ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVI., No. 7.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....97, 112
Locks and Dams on the Grand Kanawha River, W. Va. (illustrated)..... 98
Reduction of the Weight of Reciprocating Parts of Locomotives (with inset)..... 99
The Link Movement Engine (illustrated).....101
The Advantages of Ribbed Glass and of Wire Glass.101
The Detroit Municipal Electric Lighting Plant.....101
A New Method of Fireproofing (illustrated).....102
Legal Decisions of Interest to Engineers.....103
The Design and Specifications for the Fairmount Park Bridge (illustrated)..... 109
Tests of Non-Conducting Coverings for Boilers and Steam Pipes 112
The Detailed Cost of 8-in. Pipe Sewers at Ithaca, N. Y. 112
EDITORIAL NOTES..... 104
The Louisville Experiments on Mechanical Filtration—The Tests of Loaded Columns Exposed to Fire and the Fire in the Washburn & Moen Building—The Coroner's Verdict on the Atlantic City Accident—The Inherent Danger of Fast Train Speeds—A New Plan for a New York Rapid Transit System.
EDITORIAL:
Exporting American Manufactures (illustrated)....105
LETTERS TO THE EDITOR.....107
Relative Economy of Different Styles of Freehand Lettering—Correction—The Relation Between Putrid Gases and Typhoid Fever—Earthwork Slopes in the Tropics—Some Further Examples of Fictitious Accuracy—An Exhibit of American Manufactures in China—Why Does Wrought-Iron Become Weaker and Cast-Iron Stronger Under the Influence of Shocks?—How to Square a Circle and Rectify its Circumference (illustrated)—A Proposed New Location for a Nicaragua Ship Canal (illustrated.)

THE NEW YORK RAPID TRANSIT COMMISSION on Aug. 6 decided to reject the application of the Manhattan Ry. Co., on the ground that it has no legal authority to grant permission for the construction of the surface railway lines which the Manhattan desires to build. It also adopted the following resolution::

Resolved, That the Chief Engineer be, and he hereby is, directed to submit to this board at as early a date as possible routes and a general plan of rapid transit which shall conform to the following conditions:

1.—Total cost after abundant allowance for contingencies, not to exceed $30,000,000.

2.—Route to proceed from the southern terminus at or near the Postoffice and under the City Hall Park and Park row to Elm St. and Fourth Ave. to or near the Grand Central Station, and there to divide into the east and west side routes. The west side route to proceed under 42d St. to Broadway and the Boulevard to a point above 125th St. The east side route to proceed under Park Ave. and over private property to the Harlem River and across and beyond the Harlem River to as distant a point as the proposed limit of cost will permit.

3.—The railroad to have four tracks to the junction of the east and west side routes and above that point two tracks on each route, except that a third track for express service shall be added on both routes when conveniently and economically possible.

4.—The road to be in a tunnel, except on the east side, north of 98th St., and on the west side at Manhattan valley, 125th St.

5.—Plans to be so drawn as to permit further extensions in the future from the south and north termini and permitting the two and three-track portions to be widened into a four-track system without unnecessary expense or interruption of traffic.

Resolved further That the Chief Engineer be authorized to call upon counsel of the Commission for such advice as he may deem necessary in the prosecution of the work hereby directed.

THE TRACK DEPRESSION ON ATLANTIC AVE., in Brooklyn, N. Y., may be extended to the East River. We noted two weeks ago the estimate of cost submitted to the Commission in charge of the scheme, by the Long Island R. R. Co. Mr. Chas. M. Jacobs, Consulting Engineer to the railway company, has submitted the following additional estimate of the cost of depressing the tracks from Flatbush Ave. to South Ferry:

To the Hon. Eugene G. Blackford, President Atlantic Ave. Commission, Montague St., Brooklyn, N. Y.

Sir: In accordance with your request that I should consider the probable cost of extending the proposed depressed tracks of the Long Island Railroad westward from the present terminus at Flatbush Ave. to near the foot of Atlantic Ave. and South Ferry I beg to submit the following facts and estimate of cost:

The length of the extension now suggested will be about 8,130 ft.

This portion of the work will be more difficult of construction than that eastward of Flatbush Ave., and consequently more costly.

The old Atlantic Ave. tunnel, from what I am able to ascertain, is of insufficient width to accommodate modern railroad cars on double-track service, is further constructed at such grades as to be of little service other than as a deduction for quantity of excavation already executed. This item is allowed. I am of opinion that if this plan were adopted it would be necessary to put in a station near Hoyt or Smith St. and have included this in my estimate. The question of a station for terminus at the foot of Atlantic Ave. I find is a large one, and it is impossible to estimate the cost of this work until the location of the terminus can be decided upon.

My estimate of the cost of a two-track road for this extension, exclusive of diversion of sewers, water mains, etc., and of paving the surface of streets, and exclusive of relaying trolley car tracks, etc., is $1,188,058.

Yours truly, Charles M. Jacobs,
Consulting Engineer.

COMPRESED AIR MOTOR CARS are to be put in service on the Eckington & Soldiers' Home street railway in Washington, D. C. The cars are to be built by H. K. Porter & Co., of Pittsburg, Pa.

THE LOUISVILLE WATER PURIFICATION EXPERIments were completed on July 31, but the report on the same is yet to be prepared. These experiments were begun about Oct. 1, 1895, and are the most extensive and careful tests of the kind ever made in this country. Four different processes have been tried, each being operated, as we understand it, at the rate of at least 250,000 gallons a day. The processes have all been patented ones, and the plant for each system has been operated by representatives of the company controlling it, the water being delivered to the filters without charge to the companies. The details of the tests have been under the general supervision of Mr. Chas. Hermany, M. Am. Soc. C. E., Chief Engineer of the Louisville waterworks, with Mr. Geo. W. Fuller as chemist and bacteriologist in charge. Mr. Fuller has had a large force of assistants, as his work has involved the collection and examination of a large number of samples. The Western Filter Co. had both gravity and pressure mechanical filters, each of 250,000 gallons daily capacity; it was represented by Mr. Chas. T. Whittier. The O. H. Jewell Filter Co., of Chicago, and the Cumberland Manufacturing Co., of Boston, the latter making the Warren filter, each had a gravity filter of 250,000 gallons capacity; the Jewell filter was in charge of Mr. Ira H. Jewell, and the Warren of Mr. Geo. Albert Soper. All of the plants named above were installed in 1895, we believe. The fourth process was started in March, 1896, by the John T. Harris Magneto-Electric Purifying Co., of New York, and was in charge of Mr. Harris. This process, so far as can be learned, relies first upon the partial electrolytic decomposition of the water, said to have an effect somewhat akin to the use of a coagulant, with a subsequent removel of suspended matter by some mechanical means, sedimentation or rapid filtration. Mr. Chas. R. Lang is President of the Louisville Water Co., the stock of which is practically all owned by the city.

A NEW SCHEDULE OF WATER RATES at Keokuk, Ia., is to be established on the basis of the cost of building a plant equal to the existing one in efficiency and extent, if present plans are carried out. The works were built by the Keokuk Water-Works Co. in 1877-8, under a 20-years' franchise. Mr. Jacob A. Harman, of Peoria, Ill., has been engaged by the city to make the necessary estimates.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment of a freight train at Leighton, Ia., on the Keokuk & Des Moines branch of the Chicago, Rock Island & Pacific R. R. The train was an extra eastbound, and the derailment is said to have been due to the breaking of an axle on the fifth car from the engine. The number of men killed is variously reported at from three to seven.

A FREIGHT TRAIN COLLISION on the Louisville & Nashville R. R. at Mountain Creek, 68 miles south of Birmingham, Ala., on Aug. 1, is said to have been due to the engineer of one of the trains going to sleep in his cab, and running past the point where his orders required him to stop to await the passage of the other train. Two men were killed.

A BURNING TRESTLE on the Oxford & Clarksville R. R., 10 miles from Durham, N. C., caused a train wreck on Aug. 2. The engineer and fireman were injured but the other trainmen and the passengers escaped.

AN ELECTRIC CAR RAN AWAY on a steep grade of the Columbia & Donegal Electric Ry., near Columbia, Pa., on Aug. 9, and 6 persons were killed and 62 injured. The car was heavily crowded, and for some reason the motorman lost control of it while descending a heavy grade. The car at once attained terrific speed and jumped the track at a sharp curve at the foot of the hill and ran across the turnpike for a hundred yards, it then struck a train of cars and turned on its side in a deep ditch.

A BRIDGE WAS BLOWN DOWN near Thomaston, Ga., on Aug. 3. According to press dispatches, it was an "improved lattice suspension bridge 250 ft. long and built at a cost of $700."

A HEAVY RAINSTORM visited Richmond, Ind., on Aug. 8. A correspondent informs us that the rain began falling at midnight, Aug. 6, and continued for ten hours, the total precipitation being 5.9 ins., of which 3.9 ins. fell between 4 a. m. and 10 a. m. Many bridges were swept away and part of the east abutment of the National bridge over the Whitewater River, built in 1834, and forming part of the old National turnpike, was destroyed.

THE RESPONSIBILITY FOR THE ATLANTIC CITY accident will probably have to be settled in the courts, unless the two railways concerned can reach an agreement as to the proportion of damage that will be borne by each. Nearly all the deaths and injuries were to passengers on the Pennsylvania train; but the accident was caused by the engineer of the Reading locomotive.

A SWING-SPAN BRIDGE WAS WRECKED at Milwaukee, Wis., on Aug. 3, by being run into by the whaleback passenger steamer "Christopher Columbus." The bridge is located at Buffalo St. It was being opened to permit the passage of the steamer, but the difficulty of manoeuvring the boat in the narrow channel was such that the vessel struck one end of the span when it had been swung about three-quarters open. The span was pushed off the turntable, and according to newspaper reports, narrowly escaped going over the side of the pier and into the river. The "Milwaukee Wisconsin" argues as the lesson of the accident, that swinging bridges are out of date as draw-spans over narrow channels.

A PECULIAR ACCIDENT occurred at the Brooklyn Navy Yard on Aug. 8. The caisson closing the entrance to dry dock No. 2 gave way when the dock was empty, and the rush of water into the empty dock tore a half-dozen vessels loose from their moorings and did much damage to several of them. According to newspaper reports, some repairs were in progress on the interior of the caisson, and to facilitate the work a large proportion of the rock ballast with which the caisson is loaded had been removed. With the incoming tide, the buoyant effect of the water on the outside of the caisson became so great as to lift it from its groove, and the water, which was 26 ft. on the outside, of course immediately filled the dock.

THE SOUTHAMPTON-NEW YORK TRANSATLANTIC record was broken by the "St. Louis," of the American line, which reached Sandy Hook light-ship at 11.26 a. m., Aug. 7, having made the passage from The Needles in 6 days, 2 hours and 24 minutes. The ship sailed 3,055 knots and made an average speed of 20.867 knots. The daily runs were, 477 knots, 519 knots, 530 knots, 520 knots, 510 knots and 499 knots. The captain is said to have stated that there was a fog on two days lasting 16½ hours and another when near New York of 5 hours, had it not been for which he would have made still better time. In the light of the above record of daily runs it can be appreciated how much (or little) a transatlantic greyhound slows down for fog.

A NEW TRANSATLANTIC FREIGHT STEAMER is to be built by the Hamburg-American Steamship Co., and will be called the "Pennsylvania." According to newspaper reports, it will have a length of 568 ft., beam of 62 ft. and 42 ft. depth. Its displacement will be about 20,000 tons. It will be propelled by quadruple expansion engines of 7,000 HP., and will carry 13,000 to 14,000 tons of freight, 228 cabin passengers and 1,500 steerage passengers. It is claimed that she will be the largest freight steamer afloat.

ONE OF THE NEW LAKE FREIGHT STEAMERS, which has just been put in service is "The Senator," built by the Detroit Dry Dock Co., for the Wolverine Steamship Co. The vessel is 424 ft. long over all, 45 ft. 6 ins. beam, and 28 ft. deep. Her tonnage is 4,048 gross and 3,178 net. She is driven by triple-expansion engines with cylinders 22, 35, and 58 ins. and 44 ins. stroke. Forced draft is used and a speed of 14 miles an hour was made on the first trip.

EIGHT GAS-LIGHTED BUOYS are to be placed in the St. Lawrence River, between Ogdensburg, N. Y., and Cape Vincent. Each holds 176 cu. ft. and burns for several months without refilling. The buoys were furnished by the Safety Car Heating & Lighting Co., of New York city.

PROPOSALS FOR EXTENDING THE HYDE PARK water supply tunnel at Chicago, are wanted until Aug. 18. The extension will be 7 ft. in diameter and 5,300 ft. long. Mr. Joseph Downey is Commissioner of Public Works.

BIDS FOR SORTING THE RUBBISH of the city of New York, other than garbage, ashes and street sweepings, are to be received by the Department of Street Cleaning, of which Col. Geo. E. Waring, Jr., M. Inst. C. E., is Commissioner, until Aug. 26. The material will be sorted at the yards of the department, as brought there by the department. The contract will run for a year and the contractor will pay for the privilege weekly in advance.

A SHORE DRIVE FOR BROOKLYN is to be constructed soon, after plans by Olmsted, Olmsted & Eliot, Landscape Architects and Engineers. It is said that the drive will be three miles in length, extending from Bay Ridge to a point near the U. S. Military Reservation at Fort Hamilton. Mr. Elijah R. Kennedy is president and Mr. Geo. Ingram is secretary of the Shore Road Commission, whose office is at the City Hall, Brooklyn, N. Y.

LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, W. VA.

The Great Kanawha of West Virginia is one among the many navigable rivers of the United States which is being improved by the government under appropriations made in the River and Harbor bill, and expended under the U. S. War Department and its corps of engineers. The figures and statements hereafter given will show that the money on this particular stream especially, has been wisely expended, and the results attained are entirely satisfactory.

This stream is a continuation of New River, which takes its rise in Watonga Co., N. C., and is joined by the Gauley, of West Virginia, near Kanawha Falls; the distance from there to its mouth, where it empties into the Ohio River, 260 miles above Cincinnati, is about 100 miles. The river flows through a fertile and picturesque region filled with coal, salt and timber.

Originally the stream could not be depended on for navigation purposes, as at some seasons of the year the water was extremely low and many snags and loose rocks were found in the channel.

Something was done by state aid to remedy the trouble, but the results were very intermittent and unsatisfactory, as little could be accomplished except in high water.

Finally, suitable appropriations were obtained and the government undertook, by means of a complete system of large locks and dams, to obtain a constant navigable depth of at least 6 ft. throughout the whole length of the river. This necessitated the building of ten locks and dams, and locations were selected at suitable points that would give the desired result. Dams Nos. 2, 3, 4, 5, 6, 7 and 8 are already completed and in successful operation, and Nos. 9, 10 and 11, to complete the system, are well advanced, as shown by the illustrations.

In January and February, 1893, the Engineering News contained advertisements for the work, and on Feb. 16 of that year the bids for lock and dam No. 9 were opened at Charleston, W. Va. Zimmerman, Truax & Sheridan, contractors, of Duluth, Minn., were the lowest bidders, and a month later the contract for dam No. 10, situated 6½ miles further down the river, was awarded to the same firm, and about the same time No. 11 was also placed under contract with Mr. Thos. Mumford.

The photographs herewith published were taken at lock 9, and gives a good idea of the progress of the work at each place, all being at practically the same stage of advancement.

Fig. 1 shows the manner of conveying and laying stone, prior to the removal of the coffer dam around the lock walls, by means of a tramway on the tipple shown on the land wall side of the cut. The stone and material, from the railway siding and stone cutting yard on top of the bank, are conveyed and then lowered by a derrick onto tram-cars which run on a track to the point of the wall where the material is needed. Fig. 2 shows the wall after the removal of the coffer dam, and the manner of setting stone with derrick boat. The material in this case is lowered onto barges instead of tram-cars and then floated to the point needed. Fig. 3 shows the lower end of the lock walls, part of the protection crib, and the commencement of the coffer for the first section of the dam, with dredges at work. This section is 270 ft. long, 97 ft. wide. The total length of dam when completed is about 500 ft. Fig. 4 shows the completed coffer with channeler drill cutting trenches in the bed rock for anchor bolts, to be set about 9 ft. deep in concrete.

All the locks below Charleston are uniform in size, being 411 ft. in total length of masonry, 342 ft. long between quoins and 55 ft. wide in the chamber between walls. The walls at Lock No. 9 are 19 ft. above top of miter sill and 25 ft. above bed rock. Those at No. 10 are but 21 ft., as the bed rock lies higher.

The approximate quantities for Lock and Dam 9, with contract price received, are given as follows:

Kind of work Lock and dam 9:	Approximate quantities.	Bid.	Amount.
Grubbing and clearing	complete	$500.00	$500
Crib logs in cofferdam	140,000 ft.	.17	23,800
Sheathing	93,000 ft. B.M.	25.00	2,325
Cofferdam filling	21,500 cu. yds.	.65	13,975
Excavation	44,000 " "	.80	35,200
Excavation, rock	800 " "	2.00	1,600
Embankment	10,500 " "	.55	5,775
Puddling	1,300 " "	2.00	2,600
Concrete	2,500 " "	6.75	16,875
Backing masonry	5,950 " "	9.00	53,550
Rock-face masonry	2,970 " "	11.00	32,670
Pointed-faced masonry	2,200 " "	13.00	28,600
Cut-stone masonry	450 " "	18.00	8,100
Sills	520 " "	17.00	8,840
Quoins	76 " "	24.00	1,824
Coping	870 " "	18.00	15,660
Stone filling	4,200 cu. yds.	2.00	8,400
Riprap, hand-placed	3,000 " "	3.00	9,000
Paving	1,100 " "	5.00	5,500
Timber, perm. const'n.	165,000 ft. B.M.	40.00	6,600
Bolt holes in masonry	6,500 lin. ft.	.30	1,950
Total			$283,344

The quantities at No. 10 are somewhat smaller, the prices received averaging 7½% higher, and the total building price was $232,44[illegible]. At No. 11, owing to increased depth of foundations, the quantities are considerably larger, the total price amounting to a little over one-half million dollars.

As regards the class of work, the courses of masonry ranged from 1 ft. 6 ins. to 2 ft. 2 ins. in thickness, and the stones averaged about 1 cu. yd. Some of the larger ones, however, slightly exceeded 2 cu. yds. in contents. The inside faces of the lock chamber were vertical and built of "point face" and cut stone. The outside of the river wall was "rock face," with a batter of 3½ ins. to the foot from foundation to the top of the coping. The wall facing the land was made of selected backing, with each course set in from 5 to 7 ins., according to the height of the course. Immediately back of this wall was a rock drain, 3 by 8 ft., extending the whole length of the wall and intended to carry off the surface seepage and the water of some springs. The outlet was in the lower wing wall. The bed rock, especially at Lock No. 9, was very hard and uneven in places, and the projections were all carefully removed and the foundation stone well fitted to the level surface, so as to prevent water coming through under the wall. Sheet piling and clay puddle were required to cut off water from springs in the bank and the quicksand that came with the water.

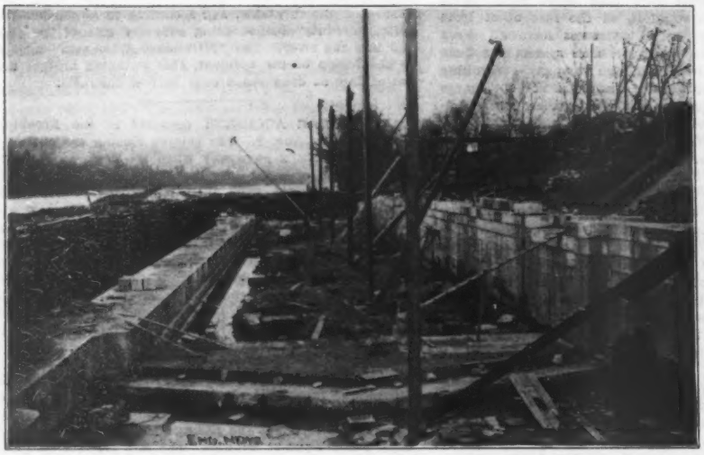


FIG. 1.—LAYING THE MASONRY FOR LOCK NO. 9, GREAT KANAWHA RIVER. Zimmerman, Truax & Sheridan, Contractors.

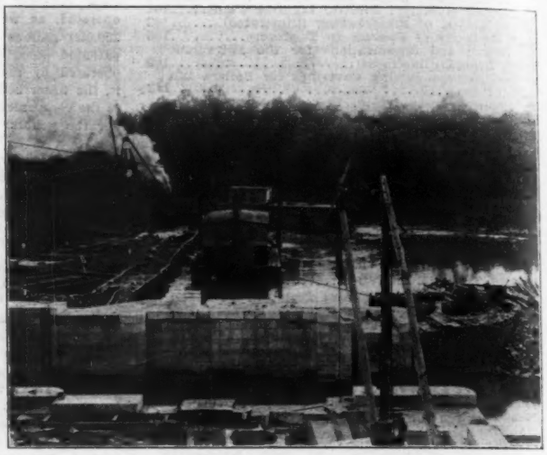


Fig. 3.—Lock Nearly Completed. Coffer Dam for First Section of Dam Begun.

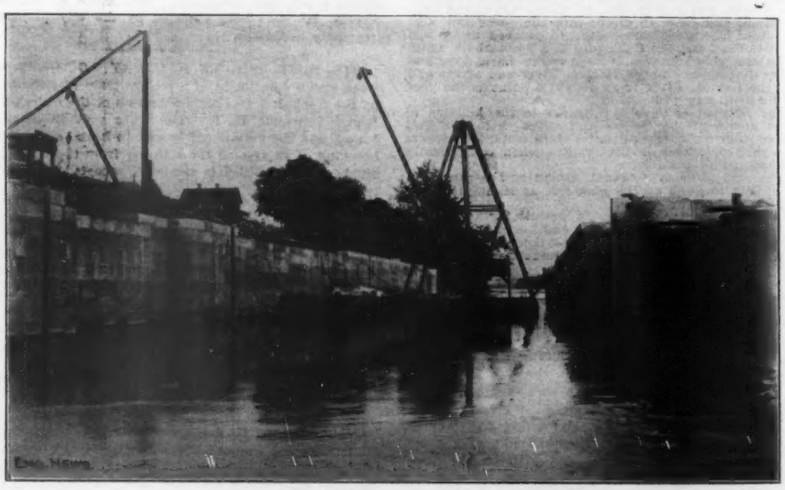


FIG. 2.—LAYING STONE FROM BARGES TO COMPLETE LOCK

Work was commenced at each place at about the same time, in July, 1893, and has been continued without stoppage to the present, except when interfered with by floods, or bad or frosty weather. No masonry is set after frost appears and the open season generally commences about June 1 and ends the latter part of November. No fatalities have occurred and but few minor accidents since the work was started.

Owing to the liability of sudden and violent rises in the river, the coffer dams used are made unusually strong; that at No. 9, enclosing the lock walls, is 542 ft. long up and down stream with shore ends 114 ft. each, or 770 ft. in total length, and 21 ft. high above bed rock. It is made of rough green timber about 7 ins. in diameter made into cribs heavily drift-bolted, 16 ft. wide and 21 ft. long. It was sunk in sections to bed rock, the trenches having been excavated by dredging, and the cribs then filled with heavy dredged material, sheathed with boards and banked with clay and gravel to a natural slope. The banking and filling are then riprapped on top with rough stone to protect them from the wash. Built in this manner they have never given trouble although subjected to the most extreme tests. In the fall of 1893 the dam was flooded and pumped out five times, and on one occasion, in 1894, there was a rise of 19 ft. in as many hours, causing heavy currents but resulting in no injury whatever to the coffer dam.

FIG. 4.—COFFER DAM COMPLETED AND PUMPED DRY, AND WORK IN PROGRESS ON DAM FOUNDATIONS.

The plant used by Zimmerman, Truax & Sheridan consists of:

1 Bucyrus 2-yd. dipper dredge, having steam speed hoists, independent swinging engines and steel boom; 1 Marion, O., 1½-yd. dipper dredge; 1 Wardwell channelling drill; 1 Sergeant-Ingersoll steam drill; 1 Lidgerwood carrier, 200 ft. span, used at quarry to convey and load stone on railway cars for transportation; 3 steam derricks or crane boats with 70-ft. booms; 2 large dump scows; 2 pumps, boilers and engines, with Baldwin's Centrifugal pumps; 8 working barges; 2 blacksmith and machine shops; 2 commissary stores; side tracks; cement houses, etc.; 25 derricks, either steam or doubledrum boom-hoisting horse power. In connection with this plant over five miles of ⅞-in. galvanized iron guy line and steel hoisting line were used. The wire rope was purchased principally from Jno. A. Roebling & Sons, and derrick fittings, engines and horse powers from the American Hoist & Derrick Co., St. Paul, Minn.

At No. 11 the lock is on the opposite side of the river from those at 9 and 10, and the material is carried across the stream from the railway siding by a Lidgerwood cableway having 2½-in. main cable, the distance between towers being 1,505 ft. The lowest part of the cable, without load, is 94 ft. above low water and it carries a maximum load of 4 tons and has worked very satisfactorily.

The stone used is a native sandstone, obtained chiefly at Lottes, W. Va., near the river, 20 miles above Lock 9. Stone for the other locks previously built has also been obtained at that point or elsewhere near the river, and has generally been satisfactory to the engineers as to strength and wearing qualities, but some difficulty has lately been found in fully satisfying the authorities. This is caused largely by the requirements for coping stone, which are of large size, as between the gate recesses on both walls for a distance of about 600 ft. all headers are used, none less than 2 ft. 6 ins. wide, 1 ft. 6 ins. thick, 6 ft. long on lock wall, and 6 ft. 11 ins. on river wall. These must be perfect in weight and texture and without flaw or defect.

The inspection and management of all the work has been under the immediate supervision of Mr. A. M. Scott, M. Am. Soc. C. E., Resident Engineer, Charleston, W. Va. There has been a rigid enforcement of specifications and close attention to minor details The chief inspectors in immediate charge of construction at the different points are Thos. E. Jeffries, C. E., and J. R. Myers, for Lock 11. A. M. Campbell, C. E., and Saml. Campbell, for Lock 10, and R. M. Stephens and Walton Venable for Lock 9.

The cement used is the Ulster Co. brand, or Hoffman brand of Rosendale, mixed 2 parts of sand to 1 of cement, except in foundations where it is used 1 to 1. Coping and cut stone were cut to ⅜-in. joints; other face stone to ½-in., and backing-bed and outside vertical joints to 1 in. The average amount of cement used was about one barrel or 300 lbs. to 2¾ yds. of masonry, and all the work has been first class in every particular.

The dam used, except at Nos. 2 and 3, which are fixed or stationary, is the Chanoine wicket type, operated by trestle service bridges. The sills of the navigation pass are from 12½ to 13 ft., and the sills of the weir from 5 to 9 ft. below upper pool levels. They have worked satisfactorily and with comparatively small expense. These dams can be lowered when the stage of water in the river will suffice over the shoals, this making an open river when the water is high enough.

The obstruction on account of ice averages but 9 days per year; while in some of the recent floods it was found impossible to ship full loaded coal barges drawing 6 ft., more than 100 days in the year. On the completion of the contracts herein mentioned this delay will be entirely obviated and a constant gage of at least 6 ft. will be maintained and with it a proportionate increase in the river traffic which for 1894 is itemized as follows:

Articles.	Quantity.	Tonnage.
Coal	25,821,000 bush...	1,032,840
Timber	19,648,000 ft. B.M.	32,920
Staves, oak	501,000.....	1,500
Tanbark	880 cords...	880
Hoop poles	115,000	230
Railroad ties, oak	580,880	87,130
Shingles	2,067,000	310
Brick	888,000	2,220
Salt	3,180 bbls....	440
Merchandise and produce on steamboats.....		64,000
Total, 1894		1,222,530

Total tonnage.

1890 (report of Chief of Engineers, p. 2,246)		1,127,232
1891 (" " " " " " 2,425)		1,225,395
1892 (" " " " " " 2,062)		1,360,750
1893 (" " " " " " 2,503)		1,116,537

There has been an increase, since 1877, of 20,637,000 bushels of coal alone.

The total expense to the government for the completed work, including superintendence and operating expenses, will approximate $4,000,000, and the expense of operating and keeping each lock and dam in repair will approximate $2,700 per year.

For information contained herein we are indebted to the reports of the engineers having this work in charge, and to the contractors for the material from which our illustrations are prepared.

REDUCTION OF THE WEIGHT OF RECIPROCATING PARTS IN LOCOMOTIVES.*

(With inset.)

It is not the intention of your committee to discuss extensively the necessity for reducing the weights of reciprocating parts. While locomotives were yet light in weight, and low boiler pressures and moderate speeds were the rule, the effects of improper counter-balancing were not serious, and consequently the matter received but scant consideration.

The great increase in the size and weights, and also in the boiler pressures of locomotives which had been made during the past ten years, to meet the demand for greater hauling capacity and higher speeds, has made it necessary to largely increase the size and strength of most of the parts. The increase in mass and strength has, perhaps, made the locomotives more capable of absorbing without injury to themselves, the greater portion of the disturbances caused by the reciprocating parts, but the numerous reports of damaged tracks, bent rails and broken bridges that have been caused by badly balanced engines, the now common practice of high maximum speeds and the introduction of the compound locomotive, with its large reciprocating weights, have all served to attract attention to this subject.

The result has been that probably during the past few years more thought and study has been given to this

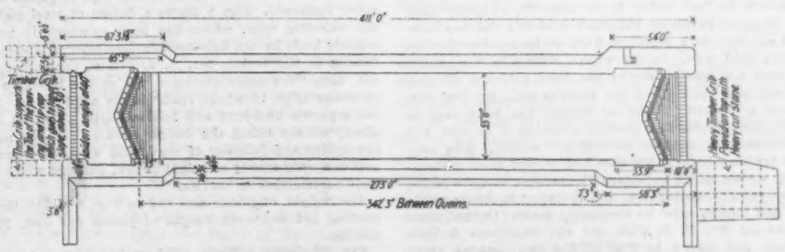


FIG. 5.—PLAN OF LOCKS NOS. 9 AND 10, GREAT KANAWHA RIVER.

*Report of a committee of the American Railway Master Mechanics' Association, presented at the Saratoga convention.

subject of counter-balancing than in all the previous history of the locomotive. That the matter has received careful attention is evidenced by the able reports that have been made to this Association and the valuable papers that have been read before the railway clubs and other societies, as well as the numerous articles that have appeared in the technical papers, so that the whole question is to-day better and more generally understood than ever before, and there is no point that has been more clearly brought out than that of the great desirability of reducing the weight of the reciprocating parts to the lowest possible limit consistent with necessary strength.

In seeking to accomplish this there are but two conditions that can properly be considered—material and design—and we shall consider them as applied to the parts under discussion.

Pistons.

The use of cast iron for pistons has been almost universal in this country, principally because they can be easily and cheaply made of this material, and also because of the low cost of maintenance and renewal. Cast iron is not only relatively a weak metal, but the stresses due to uneven contraction in cooling necessarily compels designers to make cast-iron pistons stronger than would theoretically be needed to resist only the external forces; also, in spite of the many advantages cast iron has over other iron and steel for piston material, the allowable stress cannot be great. A comparison of the relative strength and cost of mild or soft steel and cast iron would seem to indicate that the substitution of steel, either cast or in plate form, forged or pressed, or perhaps a combination of both, would offer the most practical solution of the problem of how to effect a saving in weight here without unduly increasing cost; and your committee find that much progress has been made in the use of this metal for pistons, and in most cases a large reduction in weight has been the result.

In design, the single plate form seems thus far to have been the most in favor, and undoubtedly this type permits of the greatest possible reduction in weight consistent with a proper degree of strength. For very large pistons for the low-pressure cylinder of compound engines, it is certainly to be preferred to any type that has yet been brought out. Three forms of this kind of piston are made, viz., with central plate, a very good example of which is shown in Fig. 1; the side plate as per Fig. 2, and the inclined, or Z form, as per Fig. 3.

Fig. 2.—Side Plate Piston for Locomotives.

A modification of the side plate is heavily dished and provided with a cast-iron rim, as shown in Fig. 19.

Although the single plate solid-cast or forged steel piston probably presents the best form for combining strength and lightness, the wear between piston and cylinder, due to the greater coefficient of friction, presents an objection to its use which it has been sought to overcome in various ways; and further, when the cylinder has been worn to such an extent that reboring is necessary, and the piston is consequently too small, your committee could not learn that any satisfactory method had yet been devised for enlarging it, consequently the whole piston must be thrown away. Several plans have been tried for providing the rims of steel pistons with a bearing surface of metal having better wearing qualities and that would be less liable to damage the cylinder than steel. In some instances the surface of the rim has been tinned all over to a depth of 1-16 or ⅛ in., but the tin does not hold well. In the piston shown in Fig. 4 the Richmond Locomotive Works has tried grooving the rim as shown, and then filling the grooves with tin, but this was not a success. Brass or bronze has been cast in the grooves, putting in a section, allowing it to cool, and then burning or casting on another section, thus providing for shrinkage. This plan has proved more successful, but owing to its necessary limitations, large wearing surfaces cannot be obtained; and the wear is consequently rapid, and repairs must be frequently made. In the piston designed by Mr. F. J. Cole, for the Baltimore & Ohio Railroad, and shown in Fig. 3, the two packing rings are made quite wide, but while they would possibly better meet the requirements for wear, such wide packing rings are usually considered objectionable.

Fig. 5 shows a Z plate piston made by the Rogers Locomotive Company, in which the wear seems to be very well provided for. It is designed for compound locomotives with 19-in. or 20-in. diameter horse-power, and 29-in., 30-in. and 31-in. diameter low-pressure cylinders. These all have a cast-iron "carrying-ring," AA, as shown on their face. The piston is turned to shape to receive this ring, and the latter bored to fit, sawed through at one place, sprung on and secured from turning by ½-in. copper rivets. The grooves for packing rings are then trued up to size, the edges of the carrying ring A furnish in part the bearing for the inner edge of the packing rings. As A is slightly larger in diameter than the flange of the piston, at the outer side of the packing rings, the cast steel part will not touch the cylinder until A is worn down about 1-16 in.; A can then be turned with its worn face to the top by removing the copper rivets and putting in new ones, their holes being drilled by templates to match again when A is turned 180°.

Weight of 20-in. diameter piston, with rod, Fig. 5, 358 lbs.; 31-in. diameter, complete with rod, 535 lbs.

Figs. 6 and 7 illustrate a very handsome, strong and light design for cast steel single plate pistons, and which is used in Class "K" two-cylinder compound built by the Chicago, Burlington & Quincy Railroad. Eccentric spring packing rings of cast iron are lined solid on the bottom, 12 ins. of the circle in high pressure cylinder, and 18 ins. in the low pressure cylinder. The low pressure piston rod is extended through and supported by the front cylinder head. To reduce as much as possible the weight of this extension it is made of steel pipe, which is internally threaded and screwed on to a short extension of the rod. These pistons were designed for 180 lbs. steam pressure, and weigh as follows:

Weight 20-in. cast steel piston (Fig. 6)	221 lbs.
" piston rod	94 "
" 3-in. nut	5 "
Total	320 lbs.
Weight 29-in. cast steel piston (Fig. 7)	395 lbs.
" solid rod	94 "
" hollow extension rod	46 "
" 3-in. nut	5 "
Total	540 lbs.

The Pennsylvania Railroad has designed and is using a piston which is shown by Fig. 19, and which is a combination of a single plate, dished in shape, cast or forged steel, and a cast-iron rim secured to the plate by countersunk head screws. The rim is made much the widest at the bottom, where it bears on the cylinder. This design combines the lightness and strength of the Z-plate, with the additional advantages of a good wearing surface and ease of renewal.

One objection to this design is that if great care is not exercised in fitting up the pistons, there may be leakage around the bolts. The rings must be nicely fitted and drilled to jigs, holes tapped and bolts well threaded and made steam tight. After bolts are screwed up, they should be tightly riveted up, care being taken that they are not loosened in the operation. These pistons have been in service about two years with good results.

The designs in single-plate pistons, which have been mentioned and illustrated, have been made principally for high speed and high pressures, and are given as good examples of what can be done where it is very desirable to reduce the weight to the lowest possible limit consistent with strength, the question of cost being secondary. With this type of piston, in order that the clearance spaces may not be too great, it is necessary that the shape of the cylinder heads should be made to conform to that of the piston, and it is recommended that the surfaces of pistons and cylinder heads should be turned all over, although this is not absolutely necessary, providing the work of casting and fitting up the parts is well done.

There are many who favor the bull-ring type of piston, because they believe that this form, while presenting good wearing surfaces to the cylinders, also enables the wearing parts to be easily and cheaply renewed, and repairs can be quickly made. Also this type enables the Dunbar or other sectional packing rings to be used; further, with this form of piston, as with solid piston, it is not necessary to cast irregular-shaped and excessively heavy cylinder heads, and the clearance spaces are more easily regulated. By the use of steel this type of piston can be much lightened. Fig. 8 shows a design of steel piston of the bull-ring type, which has been successfully used in engines built by the Schenectady Locomotive Works. Referring to the design, Mr. A. J. Pitkin, the superintendent, says "We make extensive use of the I-section form of piston (Fig. 9) where roads desire solid heads. When the separate bull-ring and follower type of piston is desired, we are using the design shown (Fig. 8), making the spider and follower of steel, and we have found this makes a very strong and light piston, and one which gives good satisfaction in service."

The weight of piston and rod in Fig. 8 is 318 lbs., including rod and nut; weight of piston and rod, Fig. 9, 299 lbs.

Fig. 10 shows a 20-in. solid or box piston, blue print of which was furnished your committee by the Norfolk & Western Railroad. This is made of malleable iron, and is very interesting as showing the possibilities of the application of malleable iron in the construction of light pistons. The report of Mr. G. R. Henderson, mechanical engineer of this road, to Mr. R. H. Soule, superintendent of motive power, copy of which was sent with blue print, gives results of a test made of this piston in comparison with a solid-cast iron piston. Report states that pressure was first applied to center of malleable portion to try strength of brass retaining ring, and at seventy-eight tons on wheel press the outer cast iron wearing ring broke, the malleable iron center being only slightly damaged at edges. The piston was then put on wheel drop, supported on a cast-iron ring around the outer edge, given fifty blows with 140-lb. drop falling 12 ft. This merely curled up the edges somewhat, and it was then taken to a casting breaker and given one drop of 5 ft., one of 8 ft., one of 12 ft., and two of 18 ft., when it broke badly. The solid cast-iron piston cracked at ten blows of a 140-lb. drop, and went all to pieces on the fourteenth blow, showing that the malleable piston was much the stronger. In service the pressure tending to force off the outer ring would only be the steam pressure multiplied by the area, about 15,000 lbs., which gives a factor of safety for that portion of about 10. The cast-iron piston weighed 257½ lbs., while the composite weighed but 187½ lbs., a gain of 70 lbs. Mr. Henderson thinks that this type, having shown such remarkable results, can be still further reduced in thickness, thus further reducing the weight, and he expects to make other experiments with this end in view.

Fig. 11 shows another type of malleable iron piston, blueprint of which was received by your committee from the South Carolina & Georgia Railroad. Two of these pistons were placed in a 17×24-in. passenger engine about four months ago, and have given good results; have been removed on two occasions for examination and found in good condition, and contained no condensed water. The weight of piston, with rod, is 175 lbs. as against 295 lbs. weight of old rod and piston of the bull-ring and follower type. This is a difference of 90 lbs. for each piston, a saving that would seem to argue well for the further use of this material for pistons.

Piston Rods.

Piston rods have always had a circular section, and no other section can be had as good for the same purpose. Iron has been very largely replaced by steel. The only way that the weight of this part can be reduced is to make the rod hollow, plugging the ends to prevent steam from coming through. A design for hollow rod is shown in Fig. 12, and is submitted by the Schenectady Locomotive Works, which states that it has not yet used this design. Its latest practice is to make the ends or fits larger than the body of the rod, which enables it to make the rod lighter than if the crosshead fit was made in the usual way, and also diminishes the risk of breakage. This practice, in connection with the hollow rod, would give the lightest possible form. We find that it is now the almost universal practice to secure the piston to the rod by a single nut, instead of keys or pins, as was formerly done. This is no doubt largely due to the increase in steam pressures which has been made during the past few years, and which has rendered desirable a safer and more reliable form of construction.

Mr. E. M. Herr, assistant superintendent of motive power, Chicago & Northwestern Railway, sends drawing of piston rod used on that road, and which has crosshead fit 3½ ins. diameter, while body of rod is 3¼ ins. diameter, and says: "This is not only done to lighten the rod, but to make it stronger where the strength is needed." He also says: "I am of the opinion that with the proper material we can use hollow rods to good advantage, and I am now looking this matter up with a view of trying a set experimentally."

Crossheads.

The substitution of steel for cast or wrought iron would seem to offer the most promising method of reducing the weight of crossheads, and your committee finds that in several recent designs for high-speed locomotives, as well as heavy freight locomotives, this metal has been employed with good results. Fig. 13 shows a design of crosshead of the four-bar guide type, which is probably as light as it can be made. This crosshead weighs 158 lbs. and has been successfully used in passenger engines built by the Schenectady Locomotive Works, and which have 19-in. cylinders, boiler pressure 190 lbs.

It consists of one steel casting, and the wings and wrist pin are hollow. The wearing surfaces are faced with cast iron gibs, with bosses fitted accurately by templates to the body of the crosshead, and held by brass rivets. The very light and strong crosshead shown in Fig. 14 is used by the Pennsylvania Railroad in their Class "L" high-speed locomotives; cylinders 18½ ins. diameter, boiler pressure 185 lbs. It weighs 146 lbs., and is used in connection with a single cast-iron box or enclosed guide. The wearing surfaces of the crosshead are lined with tin about ⅛-in. thick. As these surfaces are very large and well protected from dust and cinders, the wear is slight. The pin can be removed when necessary for trueing up or to disconnect for any purpose. This also permits of the use of the connecting rods with solid front ends, or without straps and bolts, thus further reducing the reciprocating weights.

Fig. 15 shows a cast steel crosshead weighing 150 lbs., used by the Norfolk & Western Railroad in its Class "D" engines, cylinders 19 ins. diameter, steam pressure 150 lbs. It is for four-bar guides, and the wearing surfaces are faced with white metal. The wings are cored out to lighten them. This crosshead, though light, seems to be of ample strength for the work required, and could perhaps be made still lighter.

For freight engines a very good design of the Laird type is shown in Fig. 16. It is made by the Rogers Locomotive Company. It weighs 198 lbs., and is designed for 20-in. cylinders and boiler pressure of 175 lbs. The body is a steel casting with a cast-iron block for wearing surfaces on guides. Referring to this type of crosshead, the superintendent, Mr. Wells, says:

"We do not advocate the Laird type for engines that make anything like high speeds, for the reason that the center of gravity of the crosshead is too far above the

center of the rod (it is out of balance), but for slow or moderate speeds it seems to give good results in practice."

The crosshead shown in Fig. 17 is used by the Pennsylvania Railroad in their new type of mogul heavy locomotive for fast freight. The compound locomotives of this type carry 205 lbs. pressure, and the simple 180 lbs. The cylinders of the former are 20 ins. and 30 ins. diameter, and of the latter 19 ins. diameter. The crosshead is all cast steel and weighs 296 lbs. The bearing surfaces are all lined with block tin. The shoes are drilled with jigs, and other shoes can be quickly substituted when necessary to retire them.

This crosshead is a very good example of what can be done by the substitution of steel for iron, the comparison of the design with the Class "R," having same type crosshead, but made of wrought and cast iron, and which is given in Table I., gives a reduction in weight of 108 lbs., with a difference of 14,141 lbs. total piston pressure in favor of the Class "R."

Main Rods.

In main rods, as now used on locomotives for very high speeds, and which are subject to the stresses due to the up-and-down motion at 400 or more revolutions per minute, it has been found necessary to place the metal where it would be most effective. This is undoubtedly the I section, with broad top and bottom, and substituting steel for iron, the allowable stresses are somewhat greater, and the web and flanges can be made thin, which has the effect of considerably reducing the weight. Your committee believe that main rods of steel and of properly designed I section, and of solid front ends, will provide about as much reduction in reciprocating weight as can be had from this source.

An excellent example of this type of main rod is shown by Fig. 18, and which is used in the Class "L" locomotive of the Pennsylvania Railroad.

The drawings accompanying the report, and which illustrate the Pennsylvania Railroad practice, have been furnished your committee by Mr. F. D. Casanave, general superintendent of motive power, who also sends in addition the accompanying table, which gives a comparison of the weight of reciprocating parts for the Class "P" 18½-in. cylinders, 160 lbs. pressure, and the Class "L" 18½-in. cylinders, 185 lbs. pressure, parts of which are shown in Figs. 14, 18 and 19. Also a comparison between their Class "R" consolidation freight engine, 20-in. cylinder, 140 lbs. pressure; and the mogul freight engine, 19-in. cylinder, 205 lbs. pressure, Figs. 17, 18 and 19. It will be seen that, notwithstanding there is a very decided increase in piston pressure of the Class "L" over the Class "P," and in the mogul over the Class "I," in both cases there is a large reduction in the reciprocating weight.

Comparison of Weights of Reciprocating Parts, P. R. R. Locomotives.

Class of engine.	"P."	"L."	"R."	Mogul.
Main rod, front end....	144½	121	171	104½
Crosshead, complete....	174	146	277	230
Piston and rod, complete.	310	269½	368	324
Total reciprocating wt.	628½	536½	816	697½
Total piston pressure.	43,008	49,729	43,982	58,123
Piston pressure per lb. of reciprocating wt.....	68.4	92.7	53.9	83.3

Your committee has endeavored to give some of the lines that can be safely followed in reducing the weight of reciprocating parts, and it may be said that in all the designs, drawings of which are shown, the expense of production, and possibly of repairs, are considerably greater than with the heavier designs made largely for cast and wrought iron, but it must be borne in mind that these designs were adopted principally because of their low first cost and cheapness of maintenance, and the question of weight was considered of secondary importance, and your committee has not been able to learn of any method of design or construction that has yet been brought out by means of which the weight of reciprocating parts can be very materially reduced without entailing considerable increased cost over former methods of construction.

H. D. Gordon, C. F. Thomas, C. G. Turner, T. A. Lawes, John A. Hill, Committee.

THE LINK MOVEMENT ENGINE.

The accompanying diagrams illustrate a curious mechanical movement adopted in a steam engine,

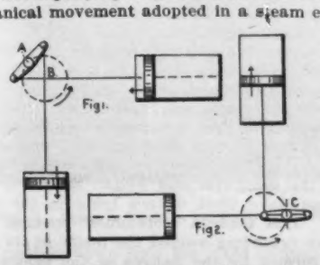


Fig. 1 and Fig. 2.—Diagrams of the Motions of Chapman's Link Movement Engine. Built by John Milne & Son, Edinburgh.

which was recently described in "The Engineer" (London). The engine is patented by Mr. G. Chapman and was constructed by Messrs. John Milne & Son, of Edinburgh. The object of the inventor is to dispense with connecting rods, and thus to produce a very compact engine. The engine has two cylinders placed at right angles with each other, each cylinder in the actual engine being inclined 45° from the vertical, instead of one being vertical and the other horizontal, as in the diagrams. "The Engineer" describes the engine as follows:

Roughly speaking, the two pistons move diagonally, and cross and recross midway at every stroke, a link, half the length of each, connecting them; a pin at each end of the link passing through the crossheads forms the respective cranks, and circular motions cause the rotation of the shafts, the pressure on the slippers being reduced to a minimum.

It is a known geometrical fact that any point in the circumference of a circle revolving on the inside of another of double the diameter will describe a straight line. Mr. Chapman's engine utilizes this principle in a way that will be readily understood by the aid of the two small diagrams annexed. Fig. 1 shows the pistons at the ends of their strokes, and Fig. 2 shows one at half stroke. The crank length is from A to B, or half the diameter of the virtual circle within which the crank pins revolve. Any of our readers accustomed to geometrical work will see that this is an extremely pretty parallel motion without further description. The details of the engine have been very neatly worked out. It is not possible to dispense with guides, because the pressure on the piston varies. But Messrs. Milne say that a new engine which they have tested gave about 78% of its indicated power on the brake at 180 revs. per minute. This, for a small engine, with cylinders only 5 in. diameter by 10 in. stroke, is very good work.

The cranks are side by side, the flying crank C, Fig. 2, acting like an ordinary drag link. This seems to us to be a very meritorious attempt to solve a difficult problem.

THE ADVANTAGES OF RIBBED GLASS AND OF WIRE GLASS.

Some very interesting experiments were carried out some time ago for the Boston Manufacturers' Mutual Fire Insurance Co., which showed that ribbed glass gave far better illumination in a room than ordinary smooth glass. The tests were made by Prof. Chas. L. Norton, of the Massachusetts Institute of Technology, and the following was his report:

The glass experimented upon was furnished by the Boston Plate and Window Glass Co. It included ribbed or fluted glass of four grades. No. 1 was 3-16-in. thick and had four ribs to the inch; No. 2 was ⅛-in. thick and had 11 ribs to the inch; No. 3 was ⅛-in. thick and had 21 ribs to the inch, and was of a strong greenish tint; No. 4 was same as No. 3, but was nearly colorless; No. 5 was ¼-in. thick rough plate; No. 6 was ⅛-in. thick white cathedral: No. 7 was ⅛-in. thick white endoyance; No. 8 was single-thick ground glass; No. 9 was yellow tinted plain glass.

Photometric comparisons of the intensity of the light from two windows similarly situated, one glazed with plain glass and the other with ribbed glass, show a difference of from 50 to 200% in favor of ribbed glass. The ribbed glass, No. 4, the best of those tested, transmitted, with ribs horizontal, in a direction perpendicular to its plane, 2.9 as much as plain glass, and in a direction 30° to the right and left, 2.5 times as much as plain glass, and in a direction 60° to the right or left, 1.9 times as much light as plain glass.

It may be well at this point to describe briefly the distribution of light in a room when illuminated through ordinary window glass. In both fair and cloudy weather the general resultant direction of the light entering through a window is downward, ordinarily at an angle of 40° or 50°. The brightest portion of the room is therefore the floor in front of the window. As a floor is not, as a rule, a good reflecting surface, a large amount of light is absorbed there and lost. Such light as is reflected goes upward and backward toward the ceiling. Such light as falls on the wall spaces between the windows must therefore be mainly light which is diffusely reflected from the floor and objects upon it. Early in the morning and toward evening the angle of the incident light with the horizontal is less, and the light therefore penetrates further into the room, but the wall spaces between windows gain but little by this greater obliquity.

If panes of ribbed glass be substituted for the plain glass the bright spot on the floor in front of the window disappears, and the entire floor, walls, and ceiling appear of sensibly the same brilliancy. The action of the ribbed glass appears to be prismatic, the greater part of the light falling on the ribbed glass at any point being refracted and spread out into a fan-shaped beam lying in a plane nearly perpendicular to the plane of the glass and to the direction of the ribs. This being recognized as the probable action, photometric measurements of the intensity were made at a distance of 8 ft. back of the glass in a horizontal plane, at five angles in this plane.

Two panes of glass whose relative merits were to be compared, were set one above the other in a large window having a southern exposure. On the inside, with the panes for centers, were built two rooms, semicircular in plan, and each about 3 ft. high and 8 ft. radius. Outside the rooms was a photometer room entirely enclosing both. The panes were 18 ins. square. At corresponding points in the two rooms holes were cut in the side walls and disks of semi-transparent membrane, ground glass or paper were placed over the holes. One hole was directly opposite the pane and the others were at 30 and 60° to the right and left. The holes in the lower room were directly under those in the upper room, and by means of a system of mirrors any two corresponding disks could be viewed side by side. If one disk was brighter than the other, the corresponding pane was obscured by a shutter sliding across it until the disks appeared equally bright. The amount of light falling upon the two disks now being the same, the amount transmitted per unit of area of the glass is inversely as the area exposed.

It must be distinctly understood that I do not mean that this gives the amount of light actually passing through the glass, but simply the amount which passes through in such a manner as to be available at the disks. Thus, if half of the ribbed glass pane has to be obscured in order to equally illuminate two corresponding disks, the ribbed glass is transmitting to the disk twice as much light per square inch as is the plain glass, and hence of two equal windows the ribbed glass window would give to objects situated in the general direction now occupied by the disk twice as much light as the plain glass window.

None of the other samples gave such efficiency as did the ribbed glasses, the fine-ribbed, No. 4, being the best. It was found that the effect of having the ribs horizontal was to give an increase of light at the middle hole, and a less increase at the sides. Whereas the vertical ribs gave a greater increase at the sides and a less increase at the middle. The horizontal ribs tend to throw the light which would otherwise fall to the floor straight ahead far into the room, while the vertical ribs spread out the light on both sides. It is, however, useless to discuss the measurements of the distribution with horizontal ribs, as the brilliancy of the glass itself is then so great as to be unbearable, rendering its use in this position out of the question, for most purposes.

The diffusion of heat was much the same as the diffusion of light. There was no spot where the heat rays from outside streamed directly in when ribbed glass was used, and objects near the window were cooler than when plain glass was used by from 4 to 15° F. However, the ribbed glass itself is hotter than the plain glass and the temperature of the air in the two cases was not sensibly different.

The company has also just published views showing the results of tests on the fire-resisting qualities of wire glass. The tests were made by the Secretary and Inspector of the Philadelphia Fire Underwriters' Association, April 30, 1896.

A brick test house was built 3 × 4 ft. inside and 9 ft. high. Iron grate bars were placed at the bottom of the house and openings left on the side walls near the ground for purposes of draft. This structure was piled for two-thirds of its height with wood treated with a liberal allowance of oil and resin. The skylight was glazed on one side with ¼-in. wired glass, on the other with ¼-in. rough glass without wire. In five minutes after the fire had been lighted the latter had broken and fallen in. The fire was maintained for forty minutes, and at the end water from a hose was played on the glass.

The wired glass in the side of the building, not being well attached by iron clamps was bent out of shape without giving way or yielding. The plate in the door was unimpaired, being set in a wooden frame fully encased in tin.

The results of this test are corroborated by a fire in the works of a stamping company at Newark, N. J., practically destroying the works. The buildings had several wire glass windows in place of iron shutters, and these withstood the heat successfully without rupture.

THE DETROIT MUNICIPAL STREET ELECTRIC LIGHTING PLANT.

The municipal electric lighting plant at Detroit has now been in operation for nearly a year. The Public Lighting Commission has just issued its first annual report, covering the construction of the plant and its operation up to June 30, 1896. The specifications for the plant and the bids for its construction were published in our issue of March 1, 1894, and the Peck boilers were illustrated and described in Engineering News for June 20, 1895. The following information is abstracted from the report:

Prior to the establishment of the municipal service, the city was lighted by contract; Detroit being one of the first cities of the country to be lighted by electricity. The contract was held by

the Brush Electric Light Co., from 1884 to 1890, inclusive, and from 1891 to 1895 the Detroit Electric Light & Power Co. supplied light, but the city plant was put in partial operation in April, 1895. The number of lamps furnished each year, the total amount paid the companies for street lighting, and the cost per lamp, from 1884 to 1894, inclusive, was as follows:

Year.	Total No.	Paid to companies.	Av. per lamp
1884	24	$3,650	$152
1885	300	71,982	240
1886	382	91,571	240
1887	565	115,490	204
1888	608	117,370	193
1889	702	128,063	182
1890	719	137,937	192
1891	1,031	133,717	130
1892	1,168	152,283	130
1893	1,279	164,831	129
1894	1,279	169,360	132

The agitation for municipal ownership began with the first annual message of Mr. H. S. Pingree, Mayor, in 1890. The subject was urged in succeeding messages for 1891, 1892 and 1893, and in March of the latter year authority was secured by the city to establish a public lighting plant. In April the people voted in favor of such a course, 15,282 to 1,245. Early in the year bids were invited for lighting the city for varying periods, from one to ten years. Only one company bid, the one then lighting the city, its figures ranging from $154 per lamp per year for a one-year contract to $102 for ten years. The city had no power to contract for more than three years; the offer for such a period was $124 a year.

The plant was constructed by a commission of six members, appointed by the Mayor and confirmed by the Council. Mr. Alex. Dow, M. Am. Inst. Elec. E., was chief engineer or city electrician, from June 14, 1893, to July 1, 1896, when he resigned and was succeeded by Mr. Walter D. Steele, who had been assistant city electrician since June 3, 1895. Mr. Jesse M. Smith, M. Am. Inst. Elec. E., and Prof. H. S. Carhart, Assoc. M. Am. Inst. Elec. E., were consulting engineers. Mr. Will F. Conant was secretary of the public lighting commission up to July 1, 1896, when he was appointed secretary and general manager.

The central station is located on the river front, where 64,175 sq. ft. of land has been devoted to the purpose. Next to the street, the station consists of a brick office building three stories high, 136 ft. front, 35 ft. deep at one end and 14 ft. deep at the other. The first floor is divided into shops and storerooms; the second is used for offices by the commission, and the third for bulky stores. A 16-ft. alley separates the office building from the power house. The latter includes a 50 × 150-ft. engine and dynamo building, 48 × 150-ft. boiler house, the two being joined by a building 17½ ft. wide, containing accommodations for the engineer, bath rooms, lockers and other rooms. A dock and railway siding give facilities for receiving supplies. The site cost $63,125, and the building, $72,248.

The steam plant includes seven Peck double deck, tubular boilers, fully described in our issue of June 20, 1895, and five triple expansion condensing engines, built by S. F. Hodge & Co. The engines have been found to give the best economy when indicating from 250 to 340 HP. each.

The electric generating plant includes 18 50-K-W. dynamos for series arc lighting, furnished by the Western Electric Co. and three 55-K-W. alternating current dynamos of the two-phase type, furnished by the Westinghouse Electric & Manufacturing Co. for the 2,500 incandescent lights required in 14 public buildings.

The distribution is divided into two sections, the first being an underground system within a one-half mile radius of the city hall and the second overhead construction. The main lines of the underground system are vitrified clay tile laid in concrete, with laterals of 2½-in. wrought iron dipped in graphite paint. The tile conduits have from 4 to 24 ducts and aggregate 181,794 ft. of single duct, costing an average of 23¾ cts., complete, including 88 manholes connected with the public sewers. The total mileage of main line, or tile conduit, is 34.43, and of lateral, or iron, 6.3 miles, the latter costing 34¾ cts. per ft., including 149 manholes. Of the 40.73 miles of underground conduits only 12.7 miles are yet occupied with public lighting wires, the balance being available for extensions, or for rental. At present 2,503 incandescent and 184 arc lamps are supplied through the underground system and 1,309 on the overhead system, the arc lamps being of 2,000 c. p. The underground cables are rubber insulated, with tape and lead covering the rubber. The arc circuit cables have 7-32 ins. of rubber around a No. 4 copper conductor. The feeder cables for the incandescent system are the same as those just described and the mains have 9-64 ins. of rubber around a No. 8 copper conductor. These cables were furnished by the Safety Insulated Wire & Cable Co., of New York. The underground work cost $87,602; the pole and wire system, $107,780; and the 135 lamp towers $85,099.

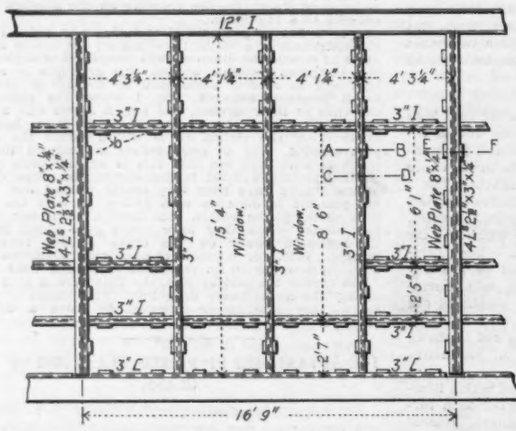


Fig. 1.—Iron Frame at Barclay Street Ferry House Ready to Receive Filling o Rock Plaster

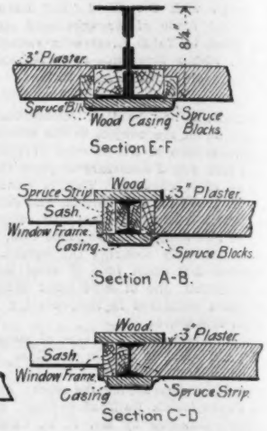


Fig. 2.—Sections Through Wall of Barclay Street Ferry House After Plaster Panels are Built in

Deducting $6,606 for the cost of operating the incandescent lamps, leaves $76,197, or $68.72 per lamp per year, for the average number of arc lamps lighted during the period. To this the report adds $16.18 per lamp for interest on bonds, making $84.70 per lamp per year, against $133.80, which the city was paying before its plant went into operation. It should be remembered, however, that the city had an offer of $102 per year for a ten-year contract in 1893, or $124 for a three-year contract. While the city did not then have authority to enter into a contract for more than three years, neither did it at that time have power to build a municipal plant. Possibly authority to make a ten-year contract could have been secured from the legislature, had that been deemed advisable, fully as easily as power to establish a municipal plant. But even taking $102 as the cost per lamp and allowing 2½% for a sinking fund, the municipal plant would give cheaper service, according to the figures in the report, than would have been obtained under a ten-year contract.

The city now has the advantage, also, of quite an extensive underground conduit system, which of course increases capital charges, especially just at present, when less than a third of it is in use, but which later on may perhaps be a source of considerable revenue.

The total cost of the lighting plant up to July 1, 1896, was $641,247, less $11,106 of credit for labor and material, or a net amount of $630,142. This includes no allowance for interest dur ng construction. About $600,000 of the cost was realized from the sale of bonds.

The report contains two tables, one relating to lamps out during nine months of contract operation, of 1,279 lamps, and the other to city operation of 1,483 lamps. According to these figures the percentage of hours out under contract ranged by months from 0.834% in January to 3.867% in December, and under city operation from 0.42% in June, 1896, to 0.201% in October, 1895.

Since Oct. 1, 1895, the entire city has been lighted by the public plant, the number of lamps on Oct. 1 having been 1,470, and on June 30, 1,492, the average number of lamps in service being 1,483.

The cost of running the plant during the nine months named was $82,803. This was divided as follows:

Coal at $2.19 per ton	$12,208
Labor and management	55,822
Carbons	5,820
Oil and rags	1,150
Teaming	1,970
Globes and nets	476
General supplies	4,472
Printing and stationery	237
Freight and transportation	126
Incandescent lamps	328
Surgeon and hospital	194
Total	$82,803

A NEW METHOD OF FIREPROOFING.

The Barclay St. ferry house, owned by the Hoboken Ferry Co., of New York city, which has just been open to the public, presents quite a new departure in fireproof construction. The aim has been to make a wall or partition which would not furnish combustible material for a fire and yet would be suitable for a structure built on a dock and subject to the vibration caused by the impact of heavily loaded ferry boats. Only those partitions which enclose portions of the building which are to be heated in winter are constructed in the manner described.

The design is by Mr. Alexander Stevens, 60 Cedar St., New York city. The steel frame work was made as rigid as possible; no bolts were used, but every connection was well riveted. The studding consists of 3-in. I-beams, weighing 5½ lbs. per ft. These vertical studs are connected at intervals by similar horizontal beams; these latter are of the same size and weight as the vertical ones and have their flanges lying in the same planes. This made a rectangular opening with a groove extending around the inside of its perimeter, formed by the flanges of the beams, the bed of the groove being the webs, Figs. 1 and 2.

After the iron frame was in position, nailing blocks, b, b, b, Fig. 1, were fastened between the flanges of the I-beams by screws through the webs. These blocks were cut of sufficient width

to come flush with the flanges on either side. The frame was now ready for the fireproofing. This is a hard plaster, made by the Rock Plaster Co., of Hoboken, N. J., and consisting primarily of lime, plaster of paris and sand, with an admixture of hair. The net work of iron I-beams, Fig. 1, composing the frame work for the walls and partitions was boarded up on both sides with 2-in. spruce lumber. These boards were held in position by verticals through which iron bolts were passed about every 4 ft. An opening from 3 to 6 ins. in width was left on one side of the wall just below the flange of each horizontal beam. Into these openings, plaster was poured as a grout

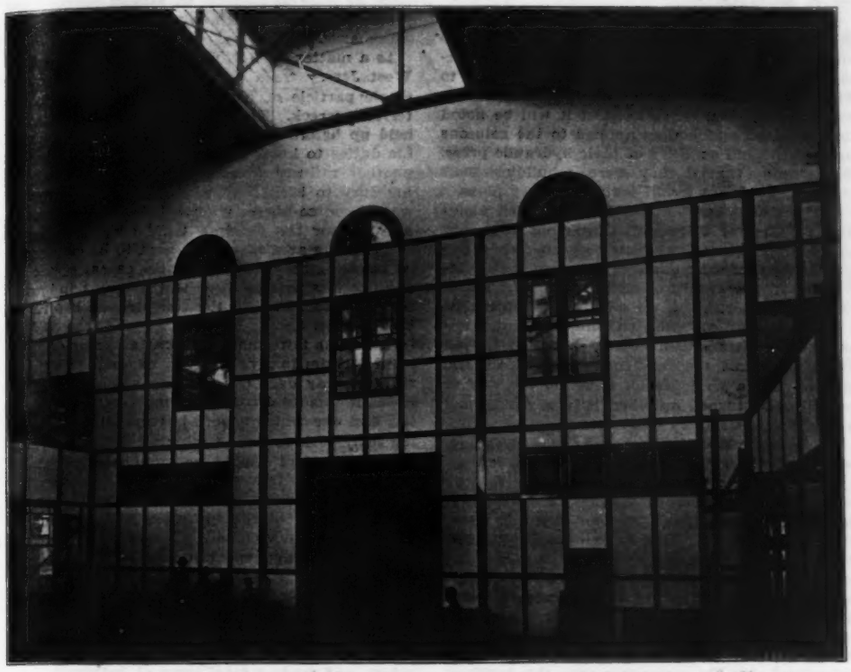


FIG. 4.—FINISHED WALL AT BARCLAY STREET FERRY HOUSE.

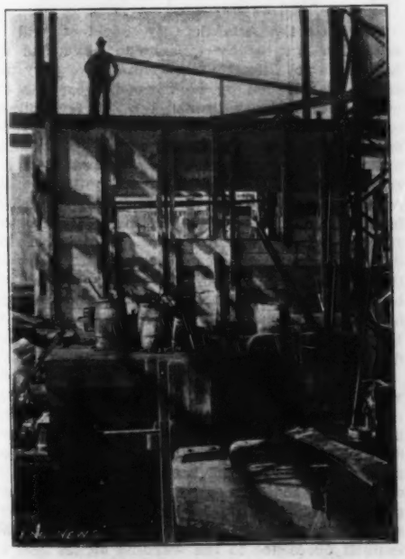


Fig. 3.—Molds in Position for Grouting in Plaster.

and settled down into the mold formed by the plank siding and the beam flanges. The work of filling the molds was done by ordinary laborers. The photograph (Fig. 3) shows one of these molds in position, the openings for pouring in the plaster being on the opposite side. To fill the top portion of the rectangular space the plaster was mixed with sufficient water to make a stiff mortar and was crowded into place with a trowel. A mason had to be employed for this part of the work, experiments with common laborers failing to give good results. The molding boards were removed in a few hours. After their removal the surface of the plaster was flush with the surfaces of the flanges of the I-beams, which showed as a series of broad rectangular lines in the mortar wall with here and there the nailing blocks. On the inside of the building, where a smooth finish was desired, the work was finished off with a coat of "Rock White." Finishing strips of mahogany lumber were then put on over the lines of the beams, Fig. 4. On the outside the finishing coat was made of plaster itself, troweled hard, and about ¾-in. thick. The outside was then washed over two or three times with a solution of sulphate of zinc in order to convert any free lime near the surface into sulphate of lime and so make the wall more impervious to the weather. Though very hard, the plaster is somewhat affected when entirely exposed to the weather. The action of the weather on such a wall is very much like the rusting of iron; a scale forms which flakes off, but the portion underneath is not affected. For this reason, if it is kept properly painted, it should last as long as the piles supporting the building. The plaster is much harder than ordinary lime plaster, but it is claimed to be more elastic and less easily fractured by the motion which it is impossible to avoid in a ferry house built on piles. Some of the plaster at the Barclay St. ferry house has been in place for a number of months and is now about as hard as it ever will become. It shows no tendency to crack and appears to fulfill all of the requirements. The cost of the plaster, including the finishing coat on both sides, was 46 cts. per sq. ft.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Validity of Law Compelling Corporation to Assign Reasons for Discharge of Employee.

The public, whether as many or one, whether as a multitude or a sovereignty, has no interest to be protected or promoted by a correspondence between discharged agents or employees and their late employers, designed, not for public, but for private information as to the reasons for discharges, and as to the import and authorship of all complaints or communications which produced or suggested them. A statute which undertakes to make it the duty of incorporated railway, express, and telegraph companies to engage in correspondence of this sort with their discharged agents and employees, and which subjects them in each case to a heavy forfeiture, under the name of damages, for failing or refusing to do so, is violative of the general private right of silence enjoyed by all persons, natural or artificial, from time immemorial, and is utterly void and of no effect. Liberty of speech and of writing is secured by the constitution, and incident thereto is the correlative liberty of silence not less important nor less sacred. Statements or communications, oral or written, wanted for private information, cannot be coerced by mere legislative mandate at the will of one of the parties and against the will of the other. Compulsory private discovery, even from corporations, enforced, not by suit or action, but by statutory terror, is not allowable where rights are under the guardianship of due process of law. It follows from the foregoing that the act of October 21, 1891, entitled "An act to require certain corporations to give to their discharged employees or agents the causes of their removal or discharge, when discharged or removed," is unconstitutional, and that an action founded thereon for the recovery of $5,000 as penalty or arbitrary damages fixed by the statutes for non-compliance with its mandate cannot be supported.—Wallace v. Georgia, C. & N. Ry. Co. (Supr. Ct. of Ga.), 22 S. E. Rep. 579

Condemnation Proceedings.

The only right of a city to condemn certain property being based on the necessity of acquiring it in order to carry out its contract to provide a railway company with terminal facilities, the fulfillment of that contract operated to extinguish any easement which the city might have acquired in the property along the right of way. Such power being primarily lodged in the state, and which may from time to time be granted to other corporate bodies, as to cities, for municipal purposes and to railway companies engaged in the public service as common carriers, and others, but always for some public use. Of this public use the state is usually the recognized judge, and her action in declaring a public use is seldom questioned by the courts. Incident to this power, however, always accompanying it, and as a constant and wholesome restraint upon it, are these two questions of fact: First, whether the property sought to be taken is really and in fact necessary for the public use; and, second, the question of just compensation, these two questions always being subject to the determination of a jury, and to be approved by the court.—Dennis Long & Co. v. City of Louisville (Ct. of App. of Ky.), 32 S. W. Rep. 272.

Liability for Defect in Street.

When a street railway company obtains a franchise from the city, agreeing to keep its tracks at proper grade, and an accident happens through its failure to do so, for which the city is liable in damages, the company is liable over to the city.—City of Fort Worth v. Allen, (Ct. of Civ. App. of Tex.) 31 S. W. Rep. 235.

Ancient Maps and Deeds.

In a suit for the recovery of real estate, a map purporting to describe, among others, the tracts in dispute, was offered in evidence. The map was not dated or signed by the surveyor who made it, but from field notes and other evidences it was shown to have been made in 1818, by a well-known and skillful surveyor, long since dead. Other surveyors testified that they had used and tested the map in their own surveys, and that it was the earliest known survey of the district it purported to describe. It also appeared that it related to an actual transaction, having been made to show the abutting owners along a proposed new road. The court held that it was admissible as an ancient map.—Whitman v. Shaw (Sup. Jud. Ct. Mass.) 44 Northeastern Rep., 333.

Special Assessments and Railroad Right of Way.

The right of way owned by a railroad may be assessed for improvements of a street on which it abuts; and in an action brought under a statute in which the contractor seeks to recover such assessment a personal judgment may be rendered against a company.—P., C., C. & St. L. Ry. Co. v. Hays (App. Ct. Ind.) 44 Northeastern Rep., 375.

Agreement of Abutting Owner to Pay His Share.

An abutting owner who agrees with one having a contract with the city to improve a street to pay his share of the cost of improving the street is personally liable for such amount, if the improvement is completed in accordance with the contract.—Burton v. Laing (Ct. Civ. App. Tex.) 36 Southwestern Rep., 298.

Stream Used as Sewer.

Where a municipality adopts and uses a stream as an open sewer, and fails to keep its channel open and to remove accumulations which obstruct the flow of water and throw it out of its banks up on the adjoining land, the land owner has the right of action for such injury, although the stream had been used as a sewer for 30 years.—Blizzard v. Danville (Sup. Ct. Penna.) 34 Atl. Rep., 846.

When Violence is Not an Excuse for Failing to Run Street Cars.

A street car company cannot excuse a failure to run its cars on the ground that it has been prevented by violence from doing so, where it does not appear that the civil authorities have failed to protect it fully in its efforts to operate its road. The fact that such company cannot get employees to accept its terms gives it no right to stop running its cars.—Loader v. Atlantic Ave. Ry. Co. (Supr. Ct. of Kings County, N. Y.) 35 N. Y. S. Rep., 999.

Conclusiveness of Estimates by Engineer.

A provision in a contract for railroad construction work that the payments therefor shall be made according to the estimates of the engineer of the railroad company, and that the final estimate of the engineer as to the quantity of the work, etc., shall be conclusive between the parties, without further recourse to appeal, does not prevent the estimates from being attacked for mistake or fraud, but merely makes them prima facie correct, as parties cannot agree in advance to oust the jurisdiction of the courts. Such fraud or mistake need also only be shown by a preponderance of the evidence.—Baltimore & O. & C. Ry. Co. v. Scholes (App. Ct. of Ind.) 43 N. E. Rep., 156.

As to the Number of Street Cars that Must be Run.

The number of cars to be run by a street car company is a matter within the discretion of the board of directors, subject to the power of the courts to compel them by mandamus to increase the number, whenever public convenience may require it.—Loeder v. Brooklyn Heights Ry. Co., 35 N. Y. S. Rep., 996.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published every Thursday at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

D. McN. STAUFFER, CHARLES WHITING BAKER.....EDITORS.
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT.....ASSOCIATE EDITORS.
CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

GEO. H. FROST, F. P. BURT.....BUSINESS MANAGERS.
ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago.....ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE.....Tribune Building, New York.
CHICAGO OFFICE.....1636 The Monadnock.
LONDON AGENCIES: KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road; SAMPSON LOW, MARSTON & Co., (Limited), St. Dunstan's House, Fetter Lane.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 3 months, $1.00; Single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug 6) of the year 1896; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The publication of the results of the Louisville water purification experiments, which terminated on July 1, as noted in another column, will be awaited with the greatest interest by a large number of engineers and sanitarians. Seldom have there been scientific experiments of so long duration conducted in a manner which promises such valuable results. The Lawrence experiments on slow sand filtration, as a means of removing bacteria from water and reducing its contents in organic matter, are of course unexcelled, but they have been conducted with small filters and have no relation to mechanical filtration and but little bearing on the problem confronting those who have to deal with the silt-bearing waters of the South and West. The Louisville experiments have been carried out in a thoroughly practical manner and with plants in every way comparable in size and modes of operation with those in actual service. The unit tank for a mechanical filtering plant very commonly has a daily capacity of 250,000 gallons, which was the size of those used in the experiments, so that larger plants would be a mere multiplication of tanks, with practically no changes in modes of operation. Further than this, the experiments have been planned and carried out under the direction of Mr. Chas. Hermony, M. Am. Soc. C. E., for many years chief engineer of the Louisville water-works, with Mr. Geo. W. Fuller, formerly of the Lawrence Experiment Station, as chemist and bacteriologist in charge, and with an ample staff of able assistants. The competing companies have had able men in charge of their plants, so that everything has been favorable to the securing of valuable results.

Expensive as these experiments doubtless have been for both the city of Louisville and the competing companies, it seems certain that the money has been well spent. The city might have wasted large sums year after year, on an improperly designed plant, had it gone ahead without the experiments, and the impartial data secured regarding their processes cannot but be of value to the companies.

Lack of space and time prevented us from commenting last week upon the very interesting tests of the resistance of loaded metal columns to heat which were recorded in our last issue. We advise any of our readers who may not already have done so to bestow careful study on these tests, as they appear to us about the most valuable that have ever been put on record. It will be noticed that the tests were made on full-size columns; that loads were applied well up to what would be used in actual practice, and that the columns were subjected to temperatures which must have equaled those which are reached in any but very severe conflagrations.

Turning now to the results of the tests, the surprising thing to us is that the columns stood up under their load so remarkably well. The committee which made the test is non-committal as to what it thinks or does not think as to the lessons to be drawn from the tests; but it will be noted that the load which they applied to the columns equaled the full capacity of their hydraulic press. We imagine that if they were rebuilding their testing plant they would instal a larger press.

A great deal has been said and written about the necessity for thoroughly protecting iron work by fireproofing, and we would by no means lessen the force of this; but every engineer who realizes the fragile nature of most fireproofing materials will be very glad, we are sure, to learn that a bare steel or cast-iron column can stand unharmed in a temperature of 1,000 to 1,200°, even though it is under a very considerable load, and further, that a good deal of abuse in the way of hose streams turned on when it is at a red heat is required to do it serious harm.

But in this connection many of our readers may recall a photograph published in our issue of July 2, showing the ruins of a steel frame factory building of the Washburn & Moen Co. at Worcester, Mass., which was burned on April 5. Here was a building with almost no wood in its construction, and with very little inflammable material inside it. A tank of fish oil used for tempering springs was set on fire and the flames swept through the building almost instantly. In a very few minutes the structure collapsed a total wreck, almost every column being bent and twisted. We understand that the experience with this building is leading many engineers to advise against the steel frame for factory buildings, and go back to wood frames as after all the safest.

Now, the question comes, why did the columns in this Worcester building fail so suddenly and entirely, whereas those in the recent tests stood up so surprisingly well? We have considered this matter with some care and are able to find but one explanation: It will be noticed that the columns tested by the committee, which we showed last week, were all what may be called "hollow" columns. The columns in the Washburn & Moen shop, on the other hand, were made up of light steel plates (or channels) with light angles riveted to their edges. Thus the column depended for stiffness entirely upon light projecting flanges, which in a rush of flame are sure to be heated quickly, and are moreover likely to be heated unevenly on the two sides. May it not be that this class of column is more susceptible to the influence of heat than columns of hollow section? If this is actually the case, the fact would have an important bearing on the design of factory building. It is to be hoped that the able committee on tests of fireproofing may carry out tests on columns of this class and may also test the effect of heating columns on one side.

The verdict of the coroner's jury on the Atlantic City accident is an excellent illustration of the difficulty of getting from a set of men who know nothing of a certain technical subject an opinion upon that subject that shall be of any value. While the jury recognized, as they could hardly fail to do, that Farr, the engineer of the Reading express, was negligent in failing to check the speed of his train in time, with the signals against him, they also held the towerman, Hauser, deserving of censure for giving the safety signal to the West Jersey train instead of to the express. Further, three of the six jurors, in an independent verdict, declared that the engineer of the excursion train erred in not exercising greater care in crossing ahead of the fast express.

The idea which governed the jurymen appeared to be that it was the business of every employee to take measures to prevent collisions at this crossing. It is fortunate, indeed, that such ideas have been abandoned in the operation of all railway lines of importance. The old idea was to make everybody alert to prevent accidents, in disregard of the well-known fact that what is everybody's business is nobody's business. The modern system is to give each employee certain fixed duties for which he, and he alone, is absolutely responsible, and in addition to make the matter of safety depend as little as possible on human memory and judgment, and as much as possible on mechanical safeguards.

As a matter of fact, neither the engineer of the West Jersey train nor the towerman deserve a single particle of blame in connection with this terrible wreck. The former obeyed the signals held up before him implicitly. It was no part of his duties to know anything about the trains on another railway which crossed his. Nor was it his duty to keep his train out of their way. It was of course his duty when the emergency came and he saw the Reading train coming down on the crossing at a speed too great to be checked to do anything possible to avert the catastrophe; but nothing was possible even to the wisest judgment or the coolest head in the few seconds before the crash came.

As for the towerman, if it was an error of judgment for him to give the slow excursion train the right of way over the crossing ahead of the express, it was an error of the most trifling character, and one which should have resulted in nothing more serious than a minute's delay to the express. The fact should be emphasized that the safety of the traveling public is not dependent upon the judgment of the towerman. If it were, then the howl of the newspapers about putting the lives of thousands of passengers at the mercy of a forty-dollar-a-month youth would be justified.

The great, prominent fact which the coroner's jury should have emphasized in its verdict, but did not, was that Farr, the engineer of the Reading express, used his judgment instead of obeying his orders, and made a fatal error of judgment when he approached the distant signal at so high a speed that he was not "prepared to stop at the home signal," as the rules required. The towerman obeyed orders; it was his duty to give the right of way to whichever train he deemed best. The engineer of the excursion train obeyed orders, for he had a clear signal for the crossing; but the engineer of the fast express did not obey orders, and on him the first responsibility for the catastrophe lies.

We trust the Atlantic City accident will be studied diligently by those who have had the hardihood to claim that the running of very fast trains is attended by no more danger than the running of ordinary trains. While a few railway officers have made themselves prominent by defending this idea, it has been ably pointed out by others that the long distance required to stop a train running at a speed of 60 to 90 miles an hour, constitutes an element of danger that can never be wholly eliminated. The Atlantic City accident fully proves the correctness of this position. We do not imagine, of course, that train speeds are to be decreased, or that fewer very fast trains will be run in future; but their dangers will, we hope, be more fully recognized, and every means will be taken to instill into the minds of engineers that fixed signals must be approached with caution.

As we said last week, the Atlantic City accident will doubtless have an influence in checking the tendency to omit derailing switches at such especially dangerous points as grade crossings and drawbridges; but it ought also to show the necessity of still more strict training of enginemen to unvarying obedience to fixed signals. We cannot place a derail in front of every fixed signal, and at most places we must rely on the engineer's implicit obedience to the warning signal held up before his eyes.

The New York Rapid Transit Commission has done wisely, we believe, in taking up anew the problem entrusted to it, and attempting to solve it on a more economical basis than was proposed in the original plan. Briefly, what is proposed is a four-track tunnel beneath the street surface from the City Hall to the Grand Central Station,

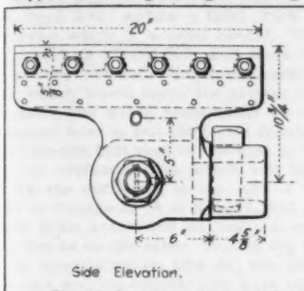


Fig. 16. Crosshead for Laird Guide, Weight, 198 lbs., Rogers Locomotive Works.

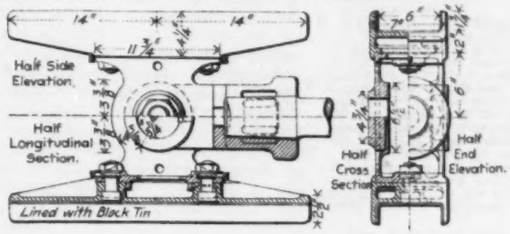


Fig. 17. Cast-Steel Crosshead, Weight, 296 lbs., Penna. R. R.

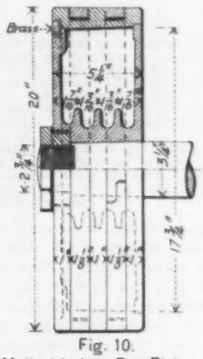


Fig. 10. Malleable Iron Box Piston, Diameter, 20 ins., Weight, 187½ lbs., Norfolk & Western R. R.

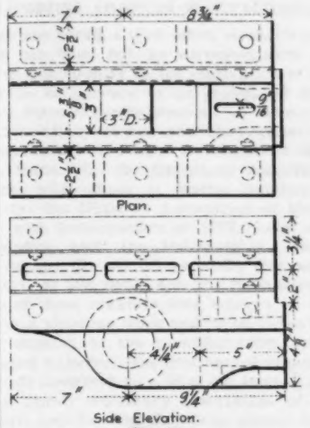


Fig. 15. Cast-Steel Crosshead for Four Bar Guides, Weight, 150 lbs., Norfolk & Western R. R.

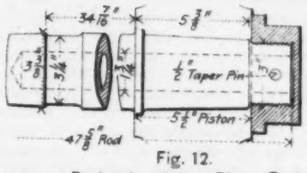


Fig. 12. Design for Hollow Piston Rod, Schenectady Locomotive Works

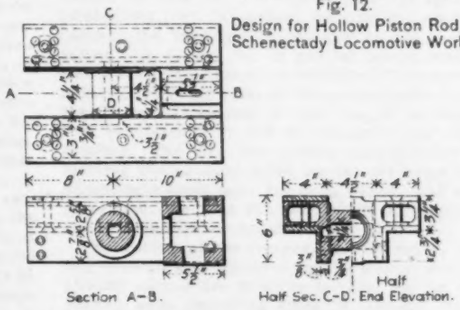


Fig. 13. Four Bar Guide Crosshead, Weight, 158 lbs., Schenectady Locomotive Works.

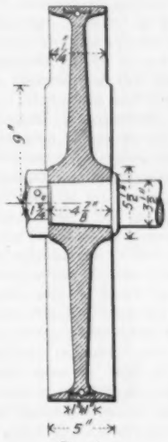


Fig. 1. 30 in. Cast-Steel Piston, Weight, 288 lbs., for Webb Compound, London & Northwestern Ry.

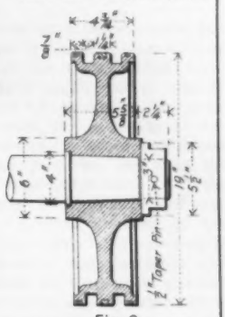


Fig. 9. Center Plate Piston, Weight, 299 lbs., Schenectady Locomotive Works.

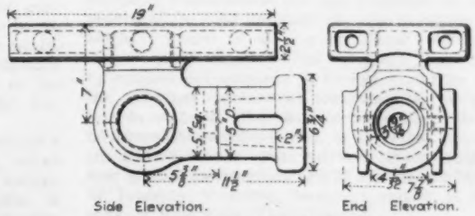
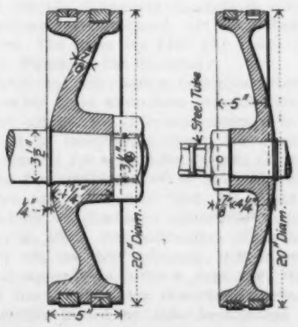


Fig. 14. Crosshead for Single Bar Guide, Penna. R. R.



Figs. 6 and 7. Cast-Steel Single-Plate Pistons, for 2 Cylinder Compound Locomotive, C. B. & Q. R. R.

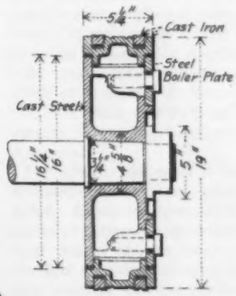


Fig. 8. Bull Ring Piston, Weight, 318 lbs., Schenectady Locomotive Works.

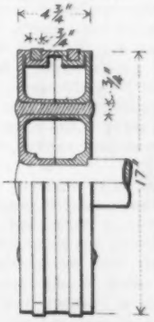
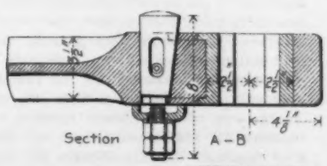


Fig. 11. Malleable Iron Box Piston, Diameter, 17 ins., Weight, 175 lbs., So. Car. & Ga. R. R.



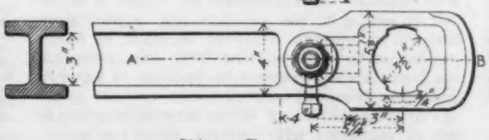


Fig. 18. Main Rod of I Section, Penna. R. R.

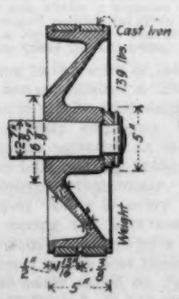


Fig. 3. Z-Plate Cast-Steel Piston, Diameter, 18 ins., Weight, 139 lbs., B. & O. R. R.

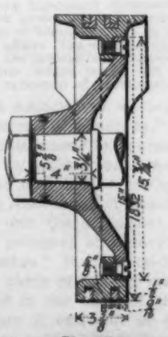


Fig. 19. Combination Steel and Cast-Iron Piston, Penna. R. R.

RECENT DESIGNS OF LIGHT-WEIGHT RECIPROCATING PARTS FOR LOCOMOTIVES.

(Accompanying a Report of a Committee of the American Railway Master Mechanics' Association.)

Fig. 4. Z-Plate Cast-Steel Piston, Diameter 31 ins., Weight, 387½ lbs., Richmond Locomotive Works.

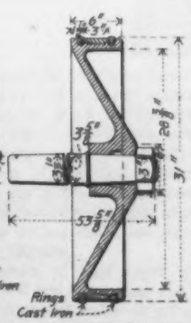


Fig. 5. Z-Plate Cast-Steel Piston, with Cast-Iron Carrying Ring, Rogers Locomotive Works.

CHAS. HART & SONS, LITH., 30 VESEY ST., N. Y.

with two-track extensions north, on the west side via Broadway and the Boulevard, and on the east side via Park Ave., adding a third track for express service where it is most needed. The limit of cost is set at $30,000,000; and there is every reason to believe that for this sum a system could be built which would serve the present need for rapid transit and which could easily be extended and enlarged later to suit the traffic requirements. We have always held that it was wise to save the five or ten million dollars which will be represented by the difference in the cost of building the road on Broadway or on Elm St., and that the road will draw practically as heavy a traffic on the one line as on the other. Should the road actually be constructed on Elm St., the Broadway shopkeepers and lot-owners who were chiefly instrumental in refusing it right of way on that street may eventually regret their action.

EXPORTING AMERICAN MANUFACTURES.

We do not recall a time when so much general interest has been felt by manufacturers everywhere in this country in the cultivation of an export trade as appears to be evident at present. At least three organizations, all of them of very recent formation, are now actively engaged in aiding manufacturers in the development of their foreign trade, viz., the Exporters' Association of America, with offices at Morris Building, New York city; the National Association of Manufacturers, with headquarters at 1757 North 4th St. Philadelphia, and the Philadelphia Museums, which occupy the old offices of the Pennsylvania R. R. Co., at 233 South 4th St., Philadelphia.

Each of these organizations appears to be carrying on a vigorous work and to be receiving the hearty support of the manufacturers, which it is designed to serve. The first named organization was briefly described on p. 33 of our issue of July 16. It is a purely voluntary association of manufacturers, and its chief functions appear to be to facilitate the export of goods by manufacturers who are not versed in the customs of foreign trade. To this end, the officers furnish to members reports of the financial standing of foreign customers and attend to consular and custom house work in connection with foreign shipments. Weekly reports of exports of goods in which each manufacturer is interested, are furnished to the members. The dues are $100 per year. Mr. Andrew H. Power is the Secretary.

The National Association of Manufacturers is a considerably more ambitious organization, which does not confine its activities entirely to foreign trade. It is interesting itself, for example, in the movement for a uniform freight classification and also the establishment of a Government Department of Commerce and Manufactures, a topic which we discussed editorially in our issue of April 23, 1896. But cultivation of foreign trade is, after all, its chief purpose; and in many respects it appears to cover a field very similar to that of the organization described above. In the last circular issued by this Association we find the following interesting statement:

> Suspicions of political purposes have done great injury to the association and have naturally retarded its progress: for there have been those outside of its membership who have not hesitated to raise the cry of politics upon every opportunity. The business motives and business methods of the association, however, have impressed themselves upon business men, and it is now pretty generally understood that the National Association of Manufacturers is essentially and wholly a business affair. The elimination of all elements of politics has given the association a membership of a representative character which would not be obtainable under the narrowing influence of partisanship.

Turning to the work of the Association, we learn that it has established a "Bureau of Publicity," at 1751 North 4th St., Philadelphia, where five persons are constantly employed. It took a prominent place in the agitation at the last session of Congress for bills relating to the restoration of treaties of commercial reciprocity, and the statement is made that "there is every prospect of favorable action during the next session." It organized a tour to South America by a party of leading manufacturers, which was noted in our issue of May 14. The party sailed on July 1, and will be absent until Sept. 1. It has also sent a committee of three to visit and report upon trade conditions in Mexico, a special Commissioner is now in Denmark, and another (Hon. Robert P. Porter) returned from Japan June 6 and will present a report to the Association on the industrial present and future of that country and its possibility of competition with American manufacturers. Preliminary steps have been taken toward the establishment of agencies for the exhibit of American manufactured goods abroad. A concession has been obtained from Venezuela for the establishment of warehouses at Caracas for the exhibit of American products, and similar concessions are proposed with other South American countries. The committee having this branch of work in charge includes Mr. John H. Converse, of the Baldwin Locomotive Works, Philadelphia, and Mr. Jas. M. Dodge, of the Link Belt Machinery Co.

The Philadelphia Museums is a concern on a quite different basis from the other two organizations described above. It appears to be aiming to aid the manufacturer in the purchase of his raw material, and the carrying on of his business quite as much as in the extension of his selling trade to foreign countries. It is practically a Philadelphia institution. The city councils chartered it June 15, 1894, and have thus far appropriated $120,000 for its expenses, of which $65,000 was appropriated this year. At present the museums are located in the building formerly used by the Pennsylvania R. R. Co. for its general offices, where floor space to the amount of 200,000 sq. ft. is available. A five years' lease of this property has been taken; but at the end of that time it is hoped that the institution will be housed in its own building. The city has already appropriated a building site of eight acres for the Museums (to which eight acres more are to be added), and appropriated this year $15,000 toward putting the site in condition for building upon.

The trustees of the museums are elected by the city councils and approved by the Mayor, and 14 already elected are to serve for life, the list including such names as Chas. H. Cramp, Thos. Dolan, Francis L. Potts, Wm. L. Singerly, Charlemagne Power, Jr., Frank Thomson and John Wanamaker. The Governor of Pennsylvania, the Mayor of Philadelphia and the President of each branch of the City Councils, are also members ex-officio. There is also a "National Advisory Board" made up of "official delegates" appointed by various governments of foreign countries and the principal commercial organizations, such as Boards of Trade, Chambers of Commerce, Manufacturers' Associations, etc., of principal cities in the United States. This Advisory Board held its first annual meeting on June 24 and elected Henry W. Peabody, of Boston, President, and W. H. Parsons, of New York, Vice-President.

Turning now to the work which this institution is doing and proposes to do: It began its work by securing as the nucleus of its collection exhibits made by various foreign countries at the Columbian Exposition. These have been added to by gifts and purchases from abroad, and have been carefully arranged and classified. In 14 rooms on the first and second floors of its present quarters, the world's supply of raw materials are grouped. Thus all the cabinet woods are in one room, another has all the dyeing materials. In another series of rooms the classification is changed to a geographical one, and one set of rooms is devoted to Mexican products, another to Central American, etc. Still another series of rooms are devoted to exhibits of foreign manufactured articles, the idea being to show the American manufacturer with what goods he will compete in entering a foreign market. The collection in the museums now comprises over 60,000 objects, to which additions are constantly being made.

Finally there is a bureau of information containing files of over 500 trade journals, statistical publications, etc. The services which the museums will give to manufacturers are summarized as follows:

> The manufacturer who wishes to introduce his goods into new markets abroad will be shown samples of whatever is now salable in those markets. Full details as to the competition he may have to meet will be furnished him as follows:
> 1. Character and variety of goods demanded in various export markets.
> 2. The country from which imported, together with the names and addresses of foreign manufacturers, where possible.
> 3. The quantity imported annually into each particular city.
> 4. The manufacturers' price at the factory.
> 5. The retail prices in each city where sold.
> 6. Transportation charges from Europe to the various foreign ports compared with rates from the United States.
> 7. Import duties.
> 8. Character of packing.
> 9. The names and addresses of importers.
>
> This bureau will also collect detailed information concerning all public improvements in progress or contemplated in Spanish America, South Africa and other new export fields, which may be of interest to the commercial classes of the United States. The information and data of this bureau will be collected through American Consuls, foreign government officials, foreign merchants and the traveling representatives of the museum.
>
> The services of the museums, including this information, are free to all who come for it. The expense of copying, compiling and postage is asked of each manufacturer to whom the monthly reports are sent regularly. This has been estimated at $50 per year.

The Museums will not become a factor in the actual sale or introduction of American goods abroad, as this is left to such institutions as export commission houses, nor will it do the work of a commercial agency in reporting on the credit of foreign buyers. It will not advertise American goods, and American manufactures will not be displayed in the Museum. Prof. W. P. Wilson is the Director of the Museums, and Messrs. Gustave Niederlein and Wm. Harper are Chiefs of the Scientific Department and of the Bureau of Information, respectively.

We have described quite fully these several enterprises for the benefit of those of our readers who may be interested in the work that they have undertaken. Let us next inquire what significance lies in this general awakening of American manufacturers to the profit of cultivating an export trade. It was common enough a half-dozen years ago to hear manufacturers say that the home market was all they cared for. But the last three years have seen such an excess of productive capacity over current demand in the home market, that prices have been reduced to points never before reached. Manufacturers who ten years ago were selling all they could produce at good profits, are nowadays finding competition so sharp that prices are reduced to the lowest living figure, and in addition more money has to be spent in selling goods in order to hold customers and keep active competitors from securing them. It is entirely natural under these circumstances that the same men who a dozen years ago were chiefly concerned lest foreign competition should reduce their profits in the home market, are now in many cases fully convinced of their ability to hold this market against the competition of English or German or French manufacturers, and not only that, but to beat them in either price or quality in the markets of Asia, Africa and South America.

We are accustomed to hear so much of British competition, German competition, Belgian competition, Japanese competition, etc., with the products of American factories, that it is not strange that many people have obtained an idea that foreign manufacturing industries exceed those of this country in magnitude. But the fact is that the United States is by far the greatest manufacturing nation of the world. According to Mulhall the following was the total value of all the manufactured goods produced by the principal nations of the world in 1888:

United States	£1,443,000,000
Great Britain and Ireland	820,000,000
Germany	583,000,000
France	485,000,000
Russia	303,000,000
Austria	253,000,000
Italy	121,000,000
Belgium	102,000,000

It will be seen that according to these figures, in 1888 the manufactures of this country equaled in value the combined output of all the factories of Great Britain and Germany, which are, after the United States, the greatest manufacturing nations. In 1890, according to the United States census, the total value of the manufactured goods produced by the United States exceeded the above enormous total by nearly 30 per cent., the figure for the total being $9,056,765,000.

Now let us see how much of this total was exported. According to the last report of the U. S. Bureau of Statistics, the total value of all exports in the year ending June 30, 1895, was $807,638,000, of which about one-sixth was manufactured articles. Thus in round numbers the total value of our manufactured goods exported in

that year was $135,000,000. What the exact total value of the output of our manufactories was during that year, there is no means of ascertaining; but we know that for two or three years after the census of 1890 was taken, the expansion of manufacturing industry in this country went on apace. Remembering that in the decade of 1880-1890, the product of United States manufactories doubled in value, it seems reasonable to believe that the fall in prices and the shrinkage in production that the past three years have seen, have not wholly offset the growth from 1890 to 1893, and that an assumption of $10,000,000,000 as the total value of U. S. manufactures in the year ending June 30, 1895, cannot be far from the truth.

Now comparing this vast sum with the value of our manufactured articles exported, we find that, in round numbers, for every dollar that the American manufacturer received from goods sold abroad, he received $75 for goods sold at home. It is evident from this that our export trade in manufactured articles is as yet a mere trifle compared with the volume of goods required to supply home consumption.

There is another profitable inquiry that we may make, and that is what proportion did the manufactured goods which we imported hold to those which were made and sold in this country. Turning again to the report of the Bureau of Statistics just issued, we find that the total value of manufactured goods imported into the United States, in the year ending June 30, 1895, was in round numbers $200,000,000. Thus if we accept the above estimate of the total value of U. S. manufactures ($10,000,000,000), and deduct from it the value of manufactures exported, we find that in round numbers there were $50 worth of American manufactured goods used in this country for every dollar's worth of manufactured goods which we imported.

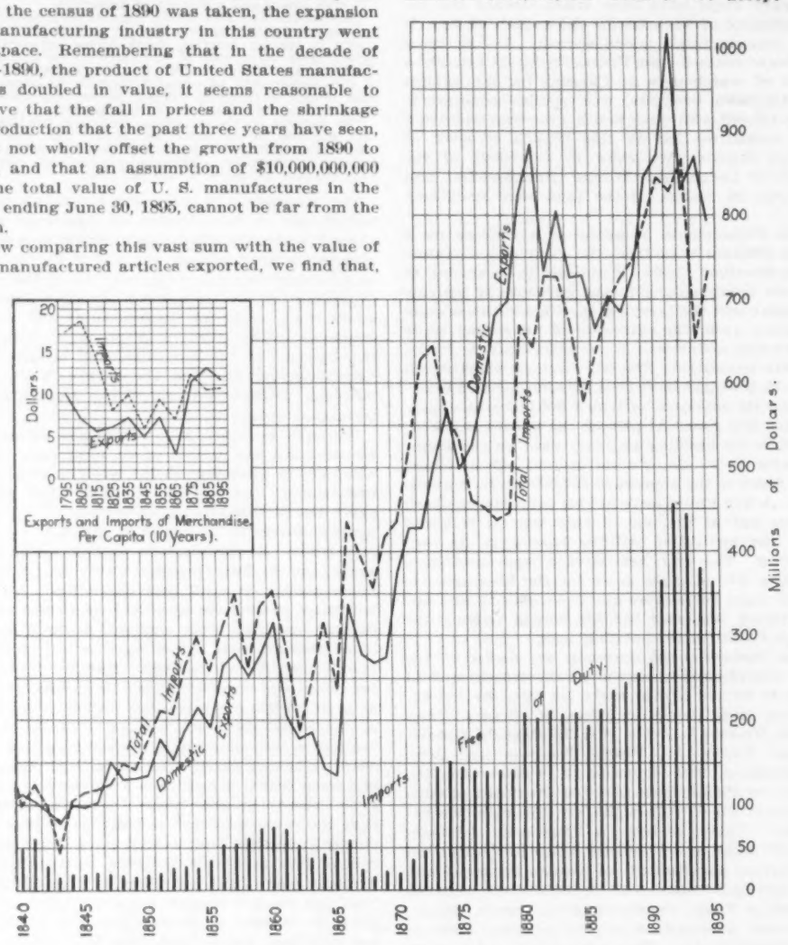


FIG. 1.—FOREIGN COMMERCE OF THE UNITED STATES, 1840 TO 1895.

And now let us see what volume of trade is being secured by the manufacturers of Europe outside of their own borders. Unfortunately, we have not at hand statistics showing the value of the exports of manufactured goods by the different countries of Europe. The total value of all exports by principal manufacturing nations is given as follows by Mulhall:

Nation.	Total value of exports in 1889.
Great Britain	£313,000,000
Germany	163,000,000
France	144,000,000
Holland	93,000,000
Russia	79,000,000
Belgium	50,000,000
Austria	44,000,000
Italy	38,000,000
Total	£924,000,000

We can only hazard a guess at what the increase or decrease has been during the past half dozen years and at what proportion of the above is manufactured articles. Suppose, however, that we assume 60% of the above to be manufactured goods and allow nothing for increase or decrease, we then obtain the present total annual value of European exports of manufactured goods (in U. S. money) at about $2,700,000,000. Certainly this is a huge enough total to offer an attraction to American manufacturers who find the home demand insufficient to absorb the entire capacity of their works. The United States exports of manufactures, as we showed above, now amount to about $135,000,000 per annum. Great Britain's exports of manufactured goods amounted in 1889 to, in round numbers, $900,000,000. Is it not reasonable to expect that the greatest manufacturing nation of the world may yet stand at the head in exports of manufactured goods?

There are some especial reasons which have been brought home to American manufacturers of late, why the cultivation of an export trade is especially desirable. We recall a notable case in the money panic of 1893, when one firm in this country which has a flourishing trade in many foreign lands, went quietly along in its business with no trouble for lack of money, while firms all about it, of equal or greater wealth, were at their wit's end to raise funds for current expenses. It needs no unusual gift of foresight to discern other reasons of financial trial in the future, and the manfacturer will be fortunate who in such periods can rely on foreign orders to keep his works running and on receipts from foreign sales to meet pressing liabilities.

Again, it is a fact which every intelligent student of commercial conditions recognizes, that a relatively small surplus of supply over demand has a marvellous effect in depressing prices. If American manufacturers can dispose abroad of their surplus products, constituting perhaps 1 per cent or 2 per cent or 5 per cent of their total product, it may serve to improve by even more than this percentage, the selling price of their entire output. This reason alone is sufficient to interest every manufacturer in the extension of American export trade. Even those who are not so situated as to be able to ship goods abroad may be benefited if some of their rivals turn their attention in this direction.

A question which will occur to almost everyone and which has already been debated more or less, is the effect which a change in our monetary standards may have upon export trade. If it is

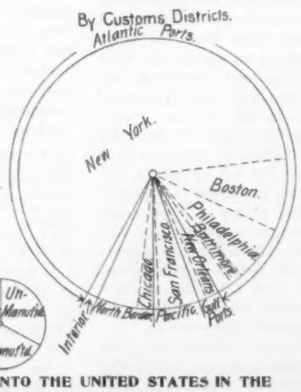
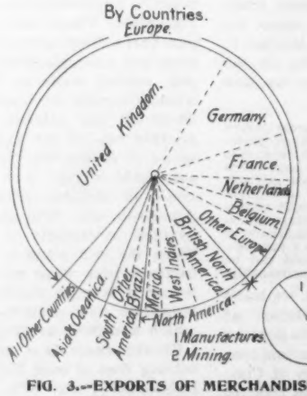


FIG. 2.—IMPORTS OF MERCHANDISE INTO THE UNITED STATES IN THE YEAR ENDING JUNE 30, 1895. TOTAL VALUE, $731,969,965.
(Classified according to countries, ports of entry and character.)



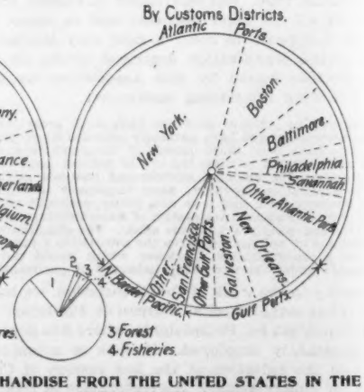


FIG. 3.—EXPORTS OF MERCHANDISE FROM THE UNITED STATES IN THE YEAR ENDING JUNE 30, 1895 TOTAL VALUE, $807,638,165.
(Classified according to countries, ports of shipment, and character.)

true, as has been generally claimed, that a change to a silver standard will lower rates of wages, measured on a gold standard, there appears to be good reason to believe that the American manufacturer would be in at least as good position to compete with his foreign rivals as he is at present. Further, in the general business depression which it is generally agreed must accompany a change in the monetary standard, manufacturers will have stronger incentives than ever to reach out for foreign customers while orders for the home trade are scarce.

Turning again to the figures of our foreign trade, we have deemed it worth while to reproduce herewith some very interesting diagrams just issued by the Bureau of Statistics of the Treasury Department. Fig. 1 shows graphically the total exports and imports for each year from 1840 to 1895. It will be seen that not till 1874 did our exports equal our imports; but that since that time they have been almost all the time materially in excess. The marvellous growth in the volume of our international exchanges which is shown by the figures, is not peculiar to the United States. Mulhall in 1889 declared that the volume of international commerce had increased forty-fold since the beginning of the century.

Fig. 2 shows graphically the total value of our imports and classifies them in three different ways: By the country from which they are brought; by the United States port at which they are entered; and by their character.

Fig. 3 shows similar information concerning our exports. The volume of trade of the different ports is a matter of especial interest. New York shows no signs of losing its supremacy as the great port of entry for imports, and it still controls nearly half the export trade. A most interesting feature is the growth of the export trade of the Gulf ports. It will be seen that New Orleans ships more than Baltimore, and Galveston more than Philadelphia. One more feature of the diagrams may be worthy of comment, and that is that Great Britain and Canada are our best customers, for they alone of all countries buy more of our goods than we buy of theirs.

Returning again in closing to the increase in the exports of our manufactured goods, it is interesting to find that the exports of the present year to Oriental ports show a gratifying increase over 1895. Since Jan. 1, of this year, 95,000 bales of American cotton goods have been shipped to China. This is a greater amount than we shipped in the whole of 1895 or 1894 or 1893. In 1892 we shipped 96,529 bales and in 1891, 142,668 bales. If the present rate is continued the shipments of the present year will eclipse our highest record. Nor is the proportion of the total trade in this quarter which America secures an insignificant one. Statistics of receipts at Shanghai show that from Jan. 1 to July 3, of the present year, there were received at that port 982,175 pieces of cotton drills and sheetings from American mills against only 613,500 pieces from all other countries. During the same period last year the figures were: American goods, 557,188 pieces; goods from all other countries, 338,471 pieces. It will be remembered that these goods are sold in direct competition with the products of the mills of Bombay, which not only have the advantage of surpassingly cheap labor and home-grown cotton, but are located within less than 5,000 miles of Shanghai by water, while the American goods must be carried by rail across the continent and then by steamer across the Pacific, making their total journey equal to half the circumference of the globe. If American manufacturers can successfully win trade under such adverse conditions, where shall limits be set to their achievements?

LETTERS TO THE EDITOR.

Relative Economy of Different Styles of Freehand Lettering.—Correction.

Sir: A typographical error appeared in your issue of July 30, in the article on "Relative Economy of Different Heights and Styles of Free-hand Letters," p. 79. In the latter part of the second paragraph the clause reading, "the height being increased 1-15 in. for each succeeding experiment," should read, "the height being increased 1-50 in. for each succeeding experiment." Yours respectfully, R. C. Vial.

Western Springs, Ill., Aug. 3, 1896.

The Relation Between Putrid Gases and Typhoid Fever.

Sir: In Engineering News of Aug. 6, a note appears regarding the relation between putrid gases and typhoid fever, referring to investigations by Dr. Giuseppe Alessi. This ground has been very well covered already by Sanarelli, and he is, I think, entitled to first honors in this line. His work at the Pasteur Institute, Paris, has been very fine. I referred to it in my "Water Supply," pp. 72 and 317. Very sincerely, Wm. P. Mason.

Hotel Kaaterskill, N. Y., Aug. 7, 1896.

Earthwork Slopes in the Tropics.

Sir: Reading the letter of Mr. Sylvanus Miller in Engineering News of June 25, and the editorial comment on same, these following suggestions occur to me:

From the language of the editor it is not clear that he intends to exclude the slope of embankment, when he speaks of earthwork slopes. It is possible that he refers to embankment slopes, as he mentions a slope of 1½ to 1, the usual slope of embankments. An earth embankment hardly becomes stable in the tropics, or anywhere else, except at a slope somewhat flatter than 1½ to 1. Mr. Miller plainly refers to the slope of excavations, and wherever the earth or other material is of such a nature that it will stand it is better to make the slope nearly vertical for excavations for railways, for the reasons given by Mr. Miller, less surface exposed to the rains, and the further reason of economical construction.

Specifications for the tropics appear to be written exactly as they are for the temperate zones. Slopes on railway excavations are made according to the nature of the material and the judgment of the engineer; but, in the end, more particularly according to the nature of the material. All of nature's laws are in full force in the tropics as elsewhere.

Mr. Miller in writing of canal construction, and that an earth slope for a canal will remain stable at any such slope as ½ to 1, will not be taken for granted by engineers. Has it been asserted by the builders of any canal that an earthwork slope of ½ to 1 was more stable than the usual slope (of 2 to 1) for canals?

One-half to 1 slopes of excavation for railways (in earth) are the rule throughout the greater part of Mexico, Arizona, New Mexico, Colorado, and I am told as far north as the Canadian Pacific Ry., but I think the slopes of ½ to 1 are hardly ever attempted in this same material for canals.

Probably the only material that would remain stable vertical would be solid rock, and we have an example of this in the Chicago Drainage Canal; vertical sides in solid rock excavation.

It is true that there is material here in Guatemala that in excavation will stand better at a slope of ¼ to 1 than flatter, because it is kept dry; but this same material if once subjected to the action of water is difficult to manage.

I have been in the tropics several years and have seen nothing to justify any hope of economy in attempting steep slopes for the Nicaragua Canal. No such hope is justified by the experience at Panama.

Charles Thornton.

Apartado 100, Guatemala, C. A., July 22, 1896.

Some Further Examples of Fictitious Accuracy.

Sir: I notice that in your editorial on "The Evils of Fictitious Accuracy," in your issue of July 30, you omitted from your summation one evil, which, although of not so much importance as those you mentioned, is still deserving of notice. I refer to the amount of time wasted by those engineers who are addicted to the habit of carrying out decimals to the bitter end when the data do not warrant it, or when such decimals have no real significance.

Take the case of railway earthwork. In spite of the fact that a difference in the cut of 1-10-ft. makes a difference of several cubic yards in the result, while a quite imperceptible bellying of the slope will make a like difference, perhaps in the same direction; some engineers will figure to the fraction of a yard, and use the approximate method of averaging end areas at that.

Some engineers seem to lose sight of the fact that the very object of their profession is to do well, safely, and for the least cost consistent therewith, what almost any fool could do very poorly and at a great expense. The real engineer will neither do careless and inaccurate work where fine work is needed, nor will he go to the other extreme of extravagant and useless refinement where only approximate results are required. Two illustrations of such "Ficticious Accuracy" have come to my notice, and they were such flagrant violations of engineering common sense that I deem them worthy of record.

Surveys and an estimate were made for a costly piece of work. A transit line was run and sufficient topography was taken to construct a tolerably accurate contoured plan, upon which a paper location was projected. Next came the profile plotted as accurately as could be done from such a paper location. The points thus determined were laboriously joined by means of a ruling pen and straight edge. After the grade line was established the center cuts were read from the profile and the quantities were computed by the average end area method, to fractions of a yard. The unit prices were, of course, mere estimates, and the amount of rock to be encountered unknown. No comment needed.

The other case was the gaging of a river some hundreds of feet in width. The engineer took fairly accurate observations by the method of rod floats. In computing the discharge (sometimes about 2,000 cu. ft. per sec.) he carried it out to the nearest hundredth of a cubic foot per day, and so reported it. It is doubtful if so eminent an engineer as the late Jas. B Francis, for example, would have felt justified in reporting the flow of a river to the nearest pint per diem, even had he been able to use a weir in the place of rod floats which reached anywhere from 1 in. to 2 ft. from the bottom of the stream. Yours truly, H. E. Abbott.

New York, Aug. 5, 1896.

An Exhibit of American Manufactures in China.

Sir: The Smithsonian Institution has received advice from the Department of State that it is the intention of the University of Peking to establish an exhibit of foreign machinery and mechanical appliances in connection with the Museum of the University. With a view to bringing this matter to the attention of the manufacturers and exporters of the United States a copy of this circular is sent to you, with the consent of the Department of State, with the request that, if you deem it proper to do so, you will publish it in the next issue of your journal.

Yours respectfully,

G. Brown Gour,

Acting Secretary.

Washington, D. C., August 10, 1896.

(The circular is as follows.—Ed.)

To the Honorable Richard Olney, Secretary of State, Washington, D. C.

Sir: The Peking University, an important educational institution of this city, conducted under the auspices of the American Methodist Episcopal Mission, has recently opened in one of its buildings a museum which it is proposed to devote largely to the exhibition of foreign machinery and mechanical appliances. This museum is visited daily by increasing numbers of people of the better classes who are interested in acquiring some knowledge of foreign manufactures and inventions, and it is believed that it can be made an important means of advertising and introducing the products of American industry. The authorities of this museum would be glad to receive and exhibit working models, photographs or drawings of machinery and inventions or specimens thereof, such as plows, ships, firearms, cannon, electric machinery, cars, locomotives, wind-mills, looms, printing presses, wagons, engines, etc. Each exhibit which may be presented to them will be marked in Chinese with the name and address of the maker, together with the description and price if desired, and a capable translator will explain their use to inquirers.

This is an opportunity which manufacturers should be glad to avail of. Peking with a population of 600,000 is the literary and political center of the Empire. Advertising here should be more profitable than in any city in China. The Peking University is the center of a wide influence. It occupies commodious foreign buildings, lighted by electricity, and is attended by hundreds of young men in search of Western learning. The museum referred to is to be conducted solely for the purpose of increasing the usefulness of the University and attracting the attention of inquirers. Exhibits of the character above described will be gratefully received by it and will be advantageously employed for the benefit of exhibitors as circumstances will permit.

Correspondence on this subject and articles for exhibition may be sent to the Peking University, Peking, China, or to Mr. Charles H. Taft, Treasurer of the Peking University, No. 78 William St., New York City, and under an arrangement with the I. M. customs will be imported to China free of duty. The authorities of the University have applied to this legation for assistance in carrying out their plan, which with a view to such assistance I request that such publicity be given this despatch as the Department may deem fit.

Charles Denby, Jr.

Legation of the United States, Peking, June 5, 1896.

Why Does Wrought Iron Become Weaker and Cast Iron Stronger Under the Influence of Shocks?

Sir: Several inquiries of this nature have come to me during the past few months from people who have repeated successfully the tests recorded in the paper entitled "The Mobility of Molecules of Cast Iron," read at the Pittsburgh meeting of the American Institute of Mining Engineers, and first published in Engineering News of Feb. 27, 1896. The reply I have heretofore given—and now offer to others, through your columns—is this:

Assuming it to be a fact that wrought iron tends to become crystalline and brittle, when subjected to repeated shocks or prolonged stress, the tendency to such change may be due to the fact that the molecules of wrought iron are mechanically forced out of their natural order of arrangement by the hammering, forging or rolling of the metal. The "fiber" of rolled or forged iron is due to the mechanical "carding," as it were, of particles of iron and cinder, or scale, distributed throughout the mass; when examined under the microscope this is quite apparent.

When a shaft, axle, or other piece of forged or wrought iron is subjected, for a long period of time, to moderate stress or repeated vibrations, it is not inconceivable that the molecules—or particles of iron—thus mechanically disturbed and released from their enforced aggregations tend to rearrange themselves according to the laws of molecular attraction; such natural arrangement would be a crystalline one.

Molten cast iron, on the other hand, when poured into a mold and allowed to congeal, tends naturally to arrange the molecules according to this law, and, if a mass of fluid iron could be cooled with absolute uniformity thoughout the section, there would, I believe, be no difference in strength between a casting, whether annealed or not annealed; this result can be approximately accomplished by pouring a test bar in a mold so arranged that the bar in cooling is surrounded by a large mass of molten metal. Such a bar differs largely from a similar bar cast from the same metal and cooled in the ordinary way. Irregular cooling or rapid surface-cooling interferes with the natural crystallization of cast iron and so creates a condition of stress, which, in some cases, exceeds the elastic limit of the metal. A car wheel, for example, unless placed, while red hot, into an annealing pit, usually breaks in half, with a loud report, while cooling, but when properly annealed it is the strongest kind of casting.

A casting will gradually relieve itself of cooling strains if kept undisturbed for a sufficient length of time, and the "shocking system" simply shortens this time by enabling a quicker rearrangement of the molecules under the influence of taps, or vibrations.

The experiments recorded in my paper point clearly to this conclusion and the very large number of tests made afford a quantitative determination of the amount of strain existing in cast-iron test bars; this is found (as might be expected) to differ widely with different kinds of cast iron.

Discarding, for the moment, the wide difference in composition between nearly pure "wrought" iron and the complex alloy called cast iron, the difference in treatment of the two would seem to be quite sufficient to explain, in the manner herein given, why wrought iron tends to become brittle (if it does) under the influence of vibrations, while cast iron is actually strengthened, to a certain extent, by similar treatment.

A. E. Outerbridge.

16th and Hamilton Sts., Philadelphia, Pa., Aug. 4, 1896.

How to Square a Circle and Rectify Its Circumference.

Sir: The following solution of the old problem of "squaring the circle," and rectifying the circumference gives remarkably accurate results and has suggested also a practical solution by a simple and handy instrument called the "Circle Rectograph."

The solution of the problem is based on the formula:

$$\left.\begin{array}{l}\text{Side of square with}\\ \text{same area as circle}\end{array}\right\} = R\sqrt{\pi} = \frac{2R^2}{\sqrt{R^2 + \left[R - 2\left(IV - V\right)\right]^2}}$$

in which R = radius of the circle, IV = the side of a square inscribed in it, and V = the side of a pentagon inscribed in it.

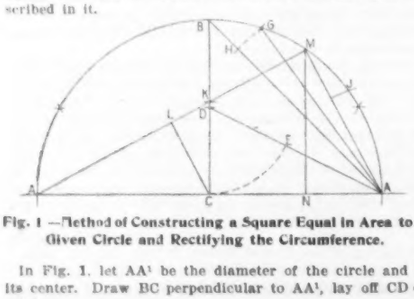


Fig. 1.—Method of Constructing a Square Equal in Area to a Given Circle and Rectifying the Circumference.

In Fig. 1, let AA^1 be the diameter of the circle and C its center. Draw BC perpendicular to AA^1, lay off $CD = \frac{BC}{2}$; draw AD and lay off DE = CD; then AE will be equal to the side of regular decagon inscribed in the circle. With AE as a chord, lay off AJ and JG, then AG will be the side of a regular pentagon or = V in the formula. Draw AB and lay off AH = AG; BH will be IV − V in the formula. Lay off BK = 2BH = 2 (IV − V); CK = R − 2 (IV − V). Draw A^1M through K and CL perpendicular to A^1M;

$$A^1M = 2A^1L.$$

In the triangle CA^1K,

$$A^1L = \frac{(A^1C)^2}{AK},$$

$$AK = \sqrt{(A^1C)^2 + (CK)^2},$$

Therefore

$$A^1L = \frac{R^2}{\sqrt{R^2 + [R - 2(IV - V)]^2}};$$

finally,

$$A^1M = 2A^1L = \frac{2R^2}{\sqrt{R^2 + [R - 2(IV - V)]^2}}$$

$= R\sqrt{\pi}$ = Side of square with same area as circle.

It remains to prove the exactness of the formula. Suppose R = 1. Then substituting the numerical values,

$$\sqrt{\pi} = \frac{2}{\sqrt{1 + [1 - 2(1.41421 - 1.17557)]^2}}$$

= 1.77245 which is the square root of π

To rectify the circumference: Draw MN perpendicular to AA^1 and draw AM; in the triangle AA^1M,

$$A^1N = \frac{(A^1M)^2}{AA^1} = \frac{R^2\pi}{2R} = \frac{R\pi}{2}$$

$$= \frac{\text{Circumference}}{4}; \text{ or Circumference} = 4A^1N$$

Since the lines CL and AM are only explanatory, and lines BC, AD, AB, AG and MN need only be drawn so far as to mark the respective intersections, both constructions can be reduced as shown in Fig. 2, and in plain words we can say:

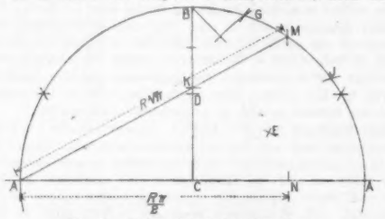


Fig. 2.—Abbreviated Construction.

1. For squaring a given circle: On a line perpendicular to the diameter given lay off from the circumference toward the center twice the difference between the sides of the inscribed square and pentagon; the chord drawn from one end of the diameter and through the point found will be the side of a square having the same area as the circle.

2. To rectify the circumference: The line through the second intersection with the circumference of the chord drawn perpendicular to the diameter cuts off

$$\frac{\text{Circumference}}{4}.$$

A glance at Figs. 1 and 2 shows that a plain triangle containing the angle AA^1M would give the point M at once, and this is indeed all that is required.

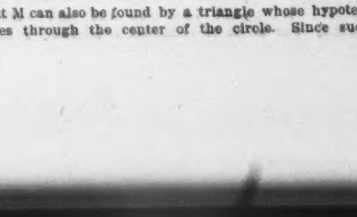


Fig. 3.—Method of Application of the "Circle Rectograph."

But M can also be found by a triangle whose hypotenuse passes through the center of the circle. Since such a triangle need only be about half the size of the former, and for very exact constructions it is important to have the intersections at the best possible angles; that is, at right angles, I have preferred the latter triangle, and have named it the "Circle Rectograph." The "Circle Rectograph" and its application is shown in Fig. 3.

Directions for its use: Through the center of the circle lay the hypotenuse of the triangle by sliding the shorter edge along the T-square, parallel to the diameter given, mark the intersection D (formerly M) with the circumference and draw DE perpendicular to AB;

$$\text{then will } AE = \frac{\text{Circumference}}{4};$$

AD = side of square with same area as circle.

The "Circle Rectograph" is made by Kolesch & Co., 138 Fulton St., New York city. H. C. Fischer,

235 E. 19th St., New York, July 14, 1896.

A Proposed New Location for a Nicaragua Ship Canal.

Sir: I hope you will forgive my troubling you again on the subject of the Nicaragua Canal, but it is my pet hobby to do my little best towards influencing some day, a real survey of the ground, and, if the Commissioners' able report is compared with my previous letters in your paper, of the following dates: July 6, 1893; June 20, Aug. 1 and 8, Oct. 10, 1895, as well as one in the "Railroad Gazette" of March 8, 1895, all antedating that report, it will be seen that nearly all my statements were justified. The Commissioners have, however, gone further than I had hoped, much to my regret, in giving the company such a fearful rating before the investing public and the U. S. Government, as to injure seriously, in my opinion, any chance for many years to come of regalvanizing the great project, either by private enterprise or government ownership; but it will be done some day, and Mr. Silvanus Miller's letter in your issue of June 25 has determined me to say another word in the hope that you will indulge me again and publish it. I am openly an enthusiast on the Nicaragua Canal, but an opponent of Mr. Menocal's route and of the methods of the old company; this attitude I have always held, as is shown by my letters above referred to. The skeleton sketch I send herewith is enough to convey my ideas on the Atlantic division without too much detail, I shall not touch on the Pacific terminus, as I think if Mr. Miller were familiar with the ground he would agree that we have but little choice there for a terminus within the limits of a reasonable expenditure. Salinas Bay is a very fair harbor, but so is the Harbor of San Francisco. As far as the Nicaragua Canal is concerned, it would cost too much to get there, and we must make the best we can of Brito.

A NEW ROUTE FOR A NICARAGUA SHIP CANAL. Proposed by J. T. Ford, Assoc. M. Inst. C. E.
(The proposed route is shown in dotted lines. The Menocal location is shown by a full line.)

Greytown, however, is quite a different problem, and there is ample room there for choice. I quite agree with Mr. Miller that the waters of the San Juan with their fearful freight of silt should be turned back to Greytown by cutting off the Colorado branch, say at or near point A; a simple pile and brush structure would do this easily, as it is practically at sea level and with little current for a great part of the year, and having the old channel to Greytown ready prepared, it would immediately scour out and again accommodate all the waters of the river as it used to do up to some 50 years ago. This feature has always formed part of my scheme, but now, when you have got the waters of the San Juan and their fearful sand drift at Greytown to leeward of us, for heaven's sake let them stay there and leave Greytown severely alone; we have then a channel with no CURRENT, and no DRIFT SAND, at sea level, practically all the way, already deep enough to float our dredges for 20 miles from the sea, and which we can deepen at small cost to any point which may be found convenient to use it. I select for argument sake point B as a likely point to leave the Colorado branch, and point C, the mouth of the Serapiqui River, as our first

communication with the San Juan. Now, it will be said, we know nothing of the country between B and C. I only allow this, however, for argument sake, and if we do not know much, more shame is it, for the Canal Company. But I DO know that a favorable line can be got at SOME level between these points approximately, and proper surveys should have been made there. The mouth of the Colorado is certainly as good a place for a port as Greytown, though they are both pretty poor ones, but here at least we would be free of all drift, with marshy lagoons of great extent affording ample protection for shipping and capable of unlimited expansion for the sole cost of dredging under the most economical conditions. At point C it certainly will not be denied that a dam CAN be built at SOME elevation, say even with crest only 40 ft. above sea level, but I believe that 50 ft. above sea level could here be obtained. Whatever it may be, however, we obtain by this dam a certain amount of deeper slack water in the San Juan above, carving out ample spill-ways for discharging the river floods, in the hills on the north bank of the river at that point. Suppose now that we could not get up as high as Ochoa by using the present San Juan channel deepened and improved, because the crest of the Serapiqui dam be too low. We can, even then, leave the San Juan at any convenient point again, up the Rio Danta perhaps (I have been over this ground personally), and if we must have the fearfully dangerous high-level Ochoa dam (which I don't admit), and the San Francisco basin, with its appalling line of high mud embankments on soft mud bottoms, we can reach it conveniently in this way and adopt the Menocal route beyond, having gained the great advantages of avoiding the absurd Divide Cut, and the equally absurd proposition of making a practicable harbor of Greytown.

I write this all as a mere hypothesis, but I have a good deal of sound information to back it up nevertheless, and at least, is it sensible, on such a great work as this, to have left the south bank of the San Juan, from Ochoa to the sea, an absolute blank, as far as real surveys are concerned, or filled in with mere fancy work, as it has been on the company's plans, simply because of the petty squabbling and jealousy between Nicaragua and Costa Rica, about their boundaries and prospective rights of dominion over the canal, and the insistence on the part of Nicaragua, that the whole canal and its eastern terminus should be on her territory? But, of course, Mr. Menocal would never have got his concession at all if he had not made that promise.

My line for the proposed survey would certainly, if practicable, economize a great deal, and it is at all events worth the trouble of being proved to be wrong. The south bank of the San Juan should never have been ignored as it has been hitherto in such an important work, and by all means let us hope that the wise suggestions of the late able Commission will be adopted and the appropriation made by Congress for a proper survey. Yours truly, J. T. Ford,

Asoc. M. Inst. C. E., Gen. Man. C. M. Ry. Co.

Cartagena, July 18, 1896.

THE STRENGTH OF A CONCRETE SLAB was recently made the subject of an interesting test at the laboratory of the Massachusetts Institute of Technology, Boston, Mass. This slab was a section of flooring designed to be used in a courtyard for a dormitory building and which had to carry coal teams, etc. Brick arches had been specified for this floor, but on account of the lower bid for concrete flooring, the authorities decided to test it. In the test the slab was supported by four I-beams spaced 4 ft. 9 ins. c. to c. and was 5 × 14 ft. × 4 ins. with ⅜-in. twisted steel bars spaced 6 ins. c. to c. and running lengthwise, and 3-16-in. bars running crosswise, 4 ft. 9 ins. apart, or directly over each I-beam. The composition of the concrete was 1 part Aisen's Portland cement, 1 part sand and 6 parts broken stone. The stone was crushed so that 2 parts passed a ½-in. ring and 4 parts a ¼-in. ring. Bricks were piled on in piers until a load of 16,770 lbs., or 724 lbs. per sq. ft. was obtained and a depression of 5-32-in. resulted. This load of course covered only the span between two I-beams. Next an impact test, consisting of dropping a timber weighing 164½ lbs. endwise onto the slab 20 ins. from the nearest I-beam and from a height of 7 ft. 10 ins. was made without causing any break or damage whatever. The third test was for shearing and consisted in thrusting with a screw jack against an I-beam laid transversly across the slab about midway between the I-beams, until a pressure of 20,700 lbs., with a deflection of 1 1-32 ins. was obtained before the concrete cracked. By means of the same screw jack a more local pressure covering an area of ½-in. × 9 ins. was tried. When placed so as to bring the pressure over two of the twisted iron bars the load borne was 6,200 lbs., and over one bar 7,700 lbs. were carried. It is stated that several faults of construction entered into this slab or else it would have shown still better results. Our authority for the above statements is the Ransome & Smith Co., of Chicago, Ill., which makes a specialty of this system of concrete and twisted iron construction.

THE DESIGN AND SPECIFICATIONS FOR THE FAIRMOUNT PARK BRIDGE.

In our issue of July 2 we published the accepted design made by the Phoenix Bridge Co., for the new bridge to be built by the Fairmount Park Transportation Co. in Fairmount Park, Philadelphia. After that date, as we briefly stated in our issue of July 16 (p. 48), a protest was presented to the Commissioners of Fairmount Park against the award of the contract, and the Commissioners referred the matter to Mr. Theodore Cooper, M. Am. Soc. C. E., for examination and report. As some of the questions at issue are of general interest to the profession, we print herewith several letters, from which our readers may gather the facts in the case and form their own conclusions.

For the easier understanding of the matter we may say that Gen. Russell Thayer, M. Am. Soc. C. E., is the Chief Engineer and Superintendent of Fairmount Park, Philadelphia, and is also Chief Engineer or Consulting Engineer (we are uncertain which), of the Fairmount Park Transportation Co., a private corporation which has obtained a franchise for the construction of an electric railway in Fairmount Park.

A little over a year ago General Thayer sent out invitations to bridge companies to submit proposals for this bridge, and several such proposals were received, but the final award was not made until June of the present year. We reprint the correspondence without further comment:

Philadelphia, Pa., May 31, 1895.

Pencoyd Iron Works, Pencoyd, Pa.:

Gentlemen: I should be pleased to receive from you on or before June 22 a proposal, accompanied by general plans and specifications for the construction of the superstructure of a steel bridge proposed to be constructed across the Schuylkill River, within the limits of Fairmount Park, by the Fairmount Park Transportation Co.

The enclosed blue print shows the general conditions existing and the general design of a structure that was prepared by me, but it is not intended to limit you to that particular design, except in so far as the length of spans, the elevation above water level, and the level and grade of the upper deck is concerned. It is quite probable that you may be able to submit a design much more attractive and more suitable.

The bridge will be a single deck structure, provided with a 10-ft. walk on north side of bridge, then a 40-ft. asphalt driveway for carriages, and next to the latter a double-track roadbed for extra heavy trolley cars. If considered desirable, the railroad portion of the structure may be separate and distinct from the driveway and footwalk, and the former may be from the latter by a space of 3 ft., but this is not required. Heavy ornamental iron railings will be required on each side of the roadway portion of the bridge, and on the outside of the railway portion.

In calculating the weight of highway portion of the structure in all its parts, the standard requirements heretofore adopted by the city of Philadelphia for such structures may be assumed, and in regard to the railway portion, the structure must be of amply sufficient strength to permit fast trains of heavily loaded cars to pass over same, with an ample factor of safety in all parts. These functions should be briefly stated in the general specifications.

Proposals will not include the masonry, and the company reserves the right to reject any or all bids. Any further information may be obtained by application to the Chief Engineer. Yours respectfully,

Russell Thayer, Chief Engineer.

Address plans and proposals to Russell Thayer, C. E., Room 127, City Hall, Philadelphia.

Philadelphia, Pa., June 10, 1895.

Pencoyd Iron Works, Philadelphia, Pa.:

Gentlemen: In order to give you ample time to properly complete specifications and proposals for the bridge proposed to be constructed across the Schuylkill River, for which you have some data, I have extended the time for receiving said proposals until 12 m., June 20, 1895. I enclose herewith additional data to be included in the requirements for the specifications for the structure.

Yours very truly,

Russell Thayer, Chief Engineer.

Memorandum of Specifications to be used in Designing the Superstructure of Bridge over Schuylkill River for Fairmount Transportation Company.

Lengths of Spans, Widths, Clearance, Etc.

The span lengths, elevation of grade line and clearance under the bridge to be as given on accompanying profile.

There is to be one sidewalk on north side of bridge 10 ft. wide, one roadway 40 ft. wide, both in the clear, and south of the roadway two tracks for electric cars, having a clearance of 12 ft. for each track.

General.

Cooper's Specifications for Highway Bridges, Edition 1890, to govern for unit stresses, quality of material, workmanship, etc., except as same may be modified below.

Structural Material.

All structural material to be soft steel except eye-bars, pins, I-beams and lateral rods, which are to be medium steel and except where it may be necessary to use rods requiring welding, in which case they are to be of wrought iron.

Roadway and Sidewalk Flooring.

The roadway and sidewalks are to be covered with asphalt pavement, carried on a solid steel floor, the asphalt wearing surface on the roadway to be 2 ins. thick and on sidewalk 1½ ins. thick, same being laid on bituminous concrete base or binder which shall be at least 3 ins. thick over highest point of the supporting steel work of the roadway, and 2 ins. thick over the highest point of the supporting steel work for the sidewalks, rivet heads not being considered in figuring the depth of concrete over the steel work.

Quality of asphalt wearing surface and bituminous binder to be as required by the specifications of the Dept. of Public Works for the City of Philadelphia.

Flooring for Railway Tracks.

Track rails to be laid on either white oak or long leaf southern yellow pine cross-ties, spaced with 6-in. openings and secured to the steel work by ¾-in. bolts, through every third tie; the cross-ties being carried on longitudinal steel stringers.

Guard rails to be 6 × 8 in, yellow pine, dapped 1 in. over ties and bolted to every third tie with ¾-in. bolts, with additional bolts through splices.

Ties to be proportioned for an extreme fiber stress of 1,000 lbs. per sq. in., considering one axle load as being supported by three ties.

Hand Railing.

There are to be three lines of heavy ornamental iron railing, costing not less than $2.50 per lin. ft. of rail; one line on outer side of sidewalk, one line between roadway and electric car tracks, and one line on outer side of car tracks.

Loads to be Used in Calculations.

Dead Loads: The dead load is to include total weight of iron and steel in the structure, the weight of paving, wooden floor system, track rails, hand railing, etc. The weight of bituminus concrete to be taken at 140 lbs. per cu. ft., and the asphalt 95 lbs. per cu. ft., and all floor lumber at 4 lbs. per ft. B. M.

Live Load: In addition to the dead load, the structure is to be designed to carry 100 lbs. per sq. ft. on the roadway and sidewalks for the highway portion of the bridge, and 1,000 lbs. per lin. ft. on each electric car track distributed so as to produce maximum stresses.

In case two electric cars coupled on each track with loads of 20,000 lbs. on each axle distributed thus:

O–7 ft.–O——23 ft.——O–7 ft.–O,

or one wagon on the roadway with loads of 20,000 lbs. on each axle, wheels 5 ft. gage and 9 ft. wheelbase produce greater stresses in any of the members than loads specified above, then these members shall be proportioned for the concentrated loads as per diagram.

Unless the stresses in the trusses produced by live load when only partially covering the roadway and sidewalk transversely exceed by more than 10% the stresses produced by live load covering entire width of roadway and sidewalks, they need not be considered.

In case the partial loading produces stresses greater by 10% than the uniform loading covering the entire width of the roadway and sidewalks, then the truss members are to be proportioned so that the unit stresses under partial loading shall not exceed the specified unit stresses by more than 10% wind load.

The structure is to be designed to resist a wind pressure of 30 lbs. per sq. ft. on the vertical projections of each truss and railing, and the vertical projections of the floor system considered as a dead load and properly divided between the top and bottom lateral system, and in addition the top lateral system is to be figured for a moving load of 150 lbs. per lin. ft.

Limiting Thickness of Material.

No material less than ⅜ in. to be used except for fillers, and no rods having a smaller area than 1 sq. in. to be used.

Commissioners of Fairmount Park, Philadelphia, Pa.:

Gentlemen: Under dates of May 31 and June 10, 1895, the A. & P. Roberts Co. received invitations to furnish a design and estimate for a bridge across the Schuylkill River in Fairmount Park. Said invitations were signed "Russell Thayer, Chief Engineer," and were accompanied by certain data and specifications for strength and loading to which the bridge should conform. In accordance therewith a design was prepared by the Pencoyd Iron Works, blue prints of which are herewith enclosed.

My attention was recently called by published articles in the daily papers, and also in the Engineering News of July 2 to the fact that the contract for this bridge had been let. I have no interest in the matter other than that of a citizen of Philadelphia, but deem it my duty to enter a protest against proceeding with the building of the structure, as shown in the articles above referred to:

I.—The bridge in question should contain three arches, not four.

II.—The masonry of the piers should be carried to the level of the roadway.

III.—The roadway, having considerable grade, will throw the arches out of a horizontal line, presenting an extremely bad effect in the adopted design.

IV.—The bridge as shown is much lighter and does not conform to the specifications issued by Chief Engineer Thayer in his invitation for proposals.

V.—At the time the present design was passed upon by your committee the plans were not in proper shape for a decision to be made, and General Thayer, as Chief Engineer, had in his possession information which it was his duty as General Thayer, Superintendent of Fairmount Park, to have furnished your committee. That the blue prints accompanying this communication were not shown

the committee, and they had no knowledge of their existence.

I am credibly informed that no actual work has been done upon this bridge other than drawings, and I must respectfully urge upon you the reconsideration of the design for this structure, which can be made as the Washington Bridge in New York, an adornment to the Park, and not simply a means to carry a trolley line across a hole.

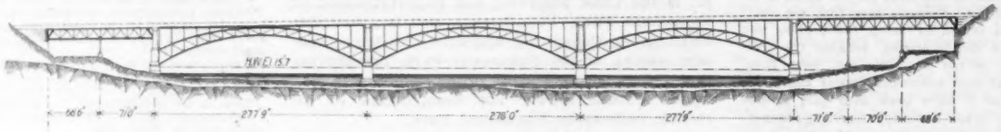
It is not a matter which can hereafter be remedied, and will stand an eye-sore, when there is no occasion for any such. Yours very respectfully,

Percival Roberts, Jr.

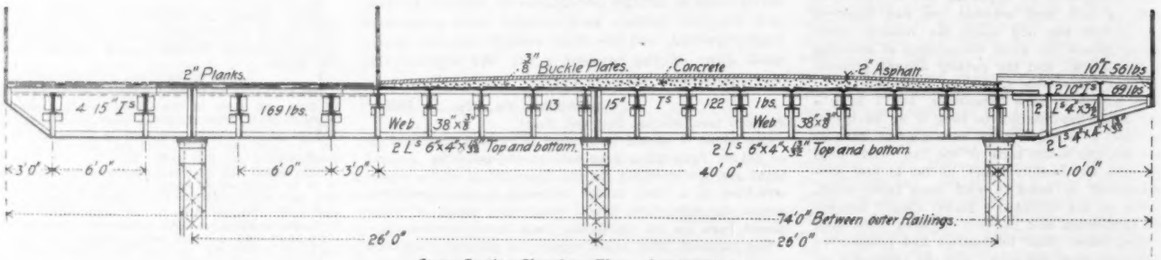
261 South Fourth St., Philadelphia, July 9, 1896.

Messrs. Geo. S. Webster and A. J. Cassatt, Committee of Fairmount Park Commissioners, Philadelphia, Pa.:

Gentlemen: Referring to the conversation had with Mr. Webster to-day, from which I understood that it is the purpose of your committee to submit the plans for the four-



General Elevation.



Cross Section Showing Floor Construction.

DESIGN BY THE PENCOYD IRON WORKS FOR THE NEW BRIDGE OVER THE SCHUYLKILL RIVER IN FAIRMOUNT PARK, PHILADELPHIA, PA.

arch bridge now contracted for by the Fairmount Park Transportation Co. to an expert bridge engineer for examination and report, I beg to present for your consideration the following facts:

I still insist that a bridge containing three arches is the only proper bridge to be erected in the location in question. Your committee having decided not to open up this matter, I will not occupy your time with my reasons for the same, but only call your attention to the fact that the piers of the accepted bridge on the low water line occupy 62 ft. of the water way of the stream, and at the bottom 84 ft. So far as I know, at the time the plans were submitted to your committee for approval they were in very defective shape, as no strain sheet accompanied them, and very little data was shown.

It is, however, stated and made part of the contract that the standard specifications of the Phoenix Bridge Co. of 1895, for highway structures, shall govern the design of the bridge.

General Thayer stated on Tuesday last, at the meeting of the Committee on Plans and Improvements, that the accepted design of the four-arch bridge complied in all respects with the specifications issued by him under date of May 31 and June 10, 1895. I regret exceedingly to be compelled to say that this statement is entirely incorrect.

I have now to enclose you copies of the above-named invitations to tender for the bridge, and specifications to govern the design of the same. I now assert that the bridge as shown in the Engineering News of July 2, 1896, is a weaker and lighter structure than called for by General Thayer, and also that the specifications of the Phoenix Bridge Co. permit a structure which must, not only under General Thayer's specifications be condemned, but is also much lighter and weaker than would be permissible under the present practice and specifications of the City of Philadelphia.

I respectfully call your attention to the following points, upon which I base the above remarks:

Comparative Permissible unit strains in Highway Bridges, Dead and Live Loads Assumed Alike.

Specifications.	Cooper's 1890.—Soft steel.	Cooper's 1890.—Medium steel.	City of Phila.	Phoenix.
Plate and shapes in tension in trusses:				
Per sq. in.	12,330	14,800	13.500	15,940
In. % of Phoenix...	77.3%	92.8%	84.7%	100.0%
Plates and shapes in tension in floor:				
Per sq. in.	12,000	14,400	13.500	17,850
In. % of Phoenix...	67.2%	80.6%	75.6%	100.0%
Compressive unit stress not reduced for buckling:				
(A) Chords.				
Per sq. in.	13,300	16,000	12,000	15,940
In. % of Phoenix...	83.4%	100.3%	75.3%	100.0%
(B) Posts.				
Per sq. in.	11,600	13,330	12,000	15,940
In. % of Phoenix...	73.1%	83.6%	75.3%	100.0%
Compressive unit stress reduced for buckling for l ÷ r = 50.				
(A) Chords for Cooper's, fixed ends for Phoenix:				
Per sq. in.	10,670	12,800	.....	14,900
In. % of Phoenix...	71.6%	85.9%	....	100.0%
(B) Posts for Cooper, hinged ends for Phoenix:				
Per sq. in.	8,330	8,670	.....	13,990
In. % of Phoenix...	59.5%	62.0%	....	100.0%
Lateral Bracing:				
Per sq. in.	15,000	18,000	.....	25,000
In. % of Phoenix...	60.0%	72.0%	....	100.0%
	Thayer's, Cooper's 1890 Modified.		Phoenix.	
	Quality of material: Soft steel, 54,000 to 62,000 (Clause 131). If medium steel used (see Clause 109). All holes reamed; all edges planed. Thayer distinctly specifies soft steel.		Quality of material: Medium steel reamed and planed, over ⅝-in. thick, 60,000 to 68,000 lbs. (Clause 66 and 67-92).	
	Live Load: 100 lbs. per sq. ft. No material less than ⅜-in. to be used except fillers.		Live Load: 100 lbs per sq. ft. floor, 80 lbs. per sq. ft. trusses. No material less than ¼-in. (Clause 31).	

From the above data it will be seen that the proposed bridge is too high in its unit strains. The quality of the material does not conform to the specifications of General Thayer, nor to Cooper's, for the same quality of material. The workmanship does not conform to the specifications of Cooper. The trusses are designed for a live load 20% lighter than called for by Thayer. The thickness of material is less than permissible by Thayer.

If, therefore, the Phoenix Bridge Co.'s specifications are correct for the designing of this bridge, the specifications of Mr. Cooper, of Mr. Cooper modified by General Thayer, and the practice of the city of Philadelphia, and other first-class cities for municipal work of this character are incorrect, and should be modified in the interests of taxpayers.

I contend that the proposed bridge due to its position and liability to full loading should be designed with the same factors of safety as would be used in any other first-class municipal work, and respectfully claim that the above-given data conclusively proves that such is not the case.

If the four-arch bridge must be used, then let it be proportioned either under General Thayer's specifications as issued, or in conformity with the practice of the Engineering Department of the city of Philadelphia.

Yours truly, Percival Roberts, Jr.

Philadelphia, Pa., July 16, 1896.

Commissioners of Fairmount Park, Philadelphia, Pa.

Gentlemen: In compliance with the request of your Sub-Committee on Plans and Improvements, I have made an examination of the general plans for the Fairmount Park bridge proposed to be built by the Fairmount Park Transportation Co.

Your sub-committee has furnished me with copies of the communications from Mr. Percival Roberts, Jr., and other papers relating to this work. The Phoenix Bridge Co. has sent me copies of the general plans of their proposed bridge and their specifications under which they propose to construct it. The general plans consist of three sheets of drawings, as follows, viz.:

1. A general elevation and cross-section at the centre of one arch.

2. Elevation of one arch, its strain sheet and plan of the metal floor.

3. Plan of cross floor beam and stringers.

As shown by these plans the structure consists of a metal approach on the west bank 180 ft. long, four main river spans each 208 ft. long between centers of piers, and a metal approach on the east bank 210 ft. long, making a total length of steel structure 1,222 ft. The carrying trusses of the approaches are lattice girders resting on vertical points. The main river spans are steel arches springing from masonry piers a few feet above high water line, and having a rise at the center of about 40 ft.

The total width of the structure is 79 ft. 3 ins., consisting of a sidewalk on the north side 12 ft. in width, a driveway 40 ft. wide, and a separate division 27 ft. 3 ins. wide reserved for a double-track electric railroad. The sidewalk and driveway are to be paved with asphalt. The approaches are to have a grade of 2.56%, and the main spans 1.202%, all rising towards the eastern bank.

The license under which this bridge is to be constructed says:

The said bridge over the River Schuylkill shall be a substantial and ornamental structure of steel or iron, with stone piers and abutments, and the plans, materials and construction thereof shall be subject to the approval of the Committee of the Commissioners of Fairmount Park on Plans and Improvements. Proper provision shall be made on the said bridge for passages of carriages and foot passengers, and no charge shall be made for their passage over the said bridge.

The only question that has been raised in reference to this requirement is whether the proposed bridge is a "suitable and ornamental structure," not whether it is the most substantial and ornamental, nor whether a more substantial and ornamental structure could not have been made. Under a general requirement like the above, a reasonable interpretation must be taken.

Capacity and Strength of the Structure.

This bridge has been proportioned for the following requirements:

1. The floor beams and stringers are to carry a load of 100 lbs. per sq. ft. over all parts of the sidewalk and driveway, or a 20-ton load on a wheel-base of 9 ft. on any part of the driveway; and for 1,000 lbs. per lin. ft. of the railroad tracks or an electric car weighing 25 tons loaded, followed by another car weighing 20 tons loaded, on a total wheel-base of 78 ft.

2. The trusses are to carry the full area of the sidewalk and driveway over the whole span loaded with 80 lbs. per sq. ft., and 1,000 lbs. per lin. ft. over each railroad track.

I consider the above requirements for the loading satisfactory and sufficient. In addition it is required that all parts of the structure shall be proportioned under these loadings so that the maximum strain shall not exceed those allowed by the Phoenix Bridge Co.'s specifications. As far as is shown upon the general plans submitted, these allowed strains have not been exceeded.

From the point of view of capacity and strength, the proposed bridge can be considered a substantial structure. There are, however, certain features of the structural parts of the work which I would recommend changed or modified:

1. The buckle plates of the driveway should be crowned upwards instead of downwards, as they can then be better drained and will be less subject to deterioration. They should also be riveted to the beams instead of bolted.

2. There should be at each side of the driveway a metal curb of an approved form.

3. The gutters should be shaped as is customary and not of the depressed form as shown. They should be drained into a pipe system leading to and down along the piers into the river. They should not drain directly into the river to the annoyance of persons using the river, or so as to permit the wind to blow it upon the structural work.

4. At the junction of spans, where expansion spaces are needed, an approved form of expansion joint should be placed in the paving that will be smooth and noiseless under the passage of vehicles.

5. There should be provisions made for putting now or at some future time hydrants at suitable distances, for washing the pavements.

6. The handrailing is not satisfactory from either the point of strength or appearance. This bridge will be liable

to have crowds upon special occasions, like boat races, which would tax severely the strength of the handrailing. It should therefore be about 4 ft. 6 ins. high above the sidewalk and of unquestioned strength. It is due to the structure that it should be an ornamental one, both from its effect upon the general external appearance of the whole structure, but also as seen from the roadways.

General Appearance of the Structure.

Where all conditions are equal, a three-spanned arch bridge is generally considered a more pleasing structure than one of an even number of spans. I estimate that under the same requirements, allowing for the saving of the cost of one pier, three spans at this point would have cost about $20,000 more. The location of the present piers was determined by conditions of the channel. The west abutment and the west river pier are now under way.

and the sudden break at the lattice girder approaches detracts very much from the dignity of the structure. This can be remedied by making the approach spans next the arch spans, half arch spans corresponding in form to the main spans.

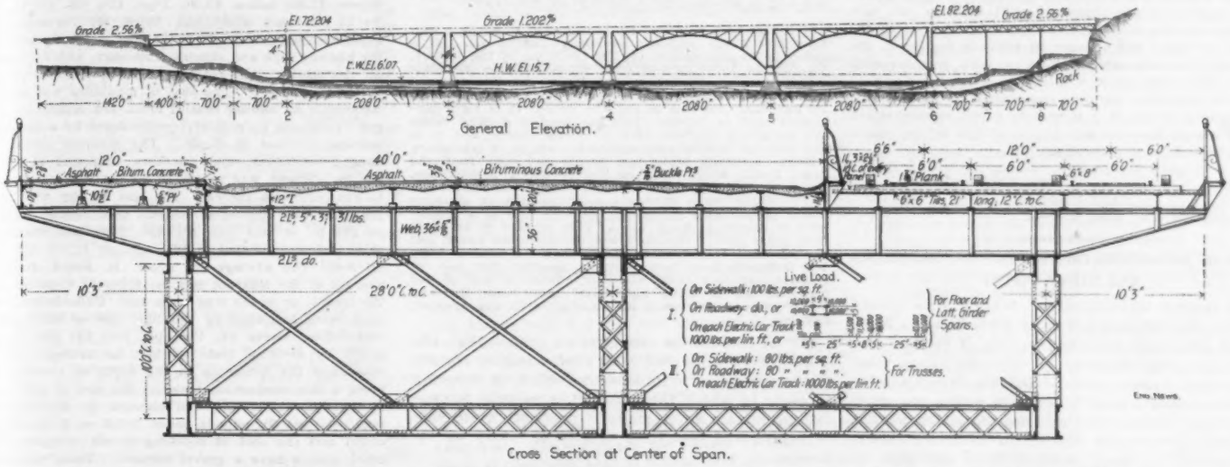
If the suggestions above indicated are carried out properly, I think you will have obtained for the City of Philadelphia a substantial and ornamental structure, and a suitable Park bridge. Yours respectfully,

Theodore Cooper, Consulting Engineer.

New York, July 30, 1896.

We reprint herewith from our issue of July 2, the design for this bridge presented by the Phoenix Bridge Co., and also show on the same scale and in the same style the design which was submitted by the Pencoyd Co. with its bid, in order that our readers may more readily compare the two. In accordance with our usual custom we have submitted proofs of the above matter to the parties interested, with an invitation to present replies or comments, for publication in connection with the above; and we have received the following letter from the Phoenix Bridge Co.:

particulars can readily be expressed by percentages, without, however, enlarging our knowledge of their respective merits. This is all Mr. Roberts seems to have shown and in a manner that is manifestly misleading. Moreover, in comparing specifications, Mr. Roberts is also misleading and unreasonable. He compares the Phoenix Bridge Co.'s specifications, prepared in 1895, after several years of experience in the manufacture and use of steel construction, with the specifications of Theodore Cooper and of the City of Philadelphia prepared as early as 1890, when steel was first being used and its behavior during manufacture and in service somewhat uncertain. Mr. Theodore Cooper has a new highway bridge specification in press and the City of Philadelphia is changing their specification to agree with experience. Mr. Roberts, in making his com-



DESIGN BY THE PHŒNIX BRIDGE CO. FOR THE NEW BRIDGE OVER THE SCHUYLKILL RIVER IN FAIRMOUNT PARK, PHILADELPHIA, PA.

I do not consider the selection of three spans instead of four as of sufficient importance, under the circumstances, to recommend any change. I think, however, that certain changes are necessary in the proposed plan to give the structure that satisfactory and pleasing appearance that its location demands.

1. The general outline of the main spans at the top is a straight line. It will appear from a distance as curved downwards and would be very unsatisfactory in looks. This line should be cambered downwards about 2 ft. at the middle of its length, giving the skyline an actual curve of 2 ft. in 800. This curve on the roadway should be gradual, merging into the grades of the approaches. The effect of the two approaches, both inclined upwards and east, can be modified by the trees on the bank.

2. The fascia shown on the plans is too small and meagre in its treatment. The fascia, cornice and handrailing should be treated as a whole both for strength and architectural effect. Plates LVII. and LVIII. of the "History of Washington bridge over the Harlem River, New York," shows the fascia, cornice and handrail of the bridge. While this is of greater magnitude than required for the bridge under consideration, it shows the desirable method of treatment.

3. Weakness of look at the ends of spans. Each span ends with a long vertical column, rising from one side

PERSPECTIVE VIEW OF DESIGN FOR FAIRMOUNT PARK BRIDGE.
By the Phœnix Bridge Co.

of the piers, so that at the point where the eye expects massiveness, there are only two long slim posts. Slender masonry piers extending above the footings of the arches would have relieved this effect on the river piers, but at the abutments a more massive work would have been required.

I think this can be largely remedied by making the metal work over the piers of a more massive looking character, without the use of false ornamentation. In like manner at the ends of the bridge the single light post

---

Sir: I am quite familiar with the correspondence of Mr. Percival Roberts, Jr., Vice-President Pencoyd Iron Works, in connection with the bridge now being constructed over the Schuylkill River in Fairmount Park, Philadelphia, which correspondence you kindly forwarded to me; I have also seen considerable additional correspondence that Mr. Roberts has seen fit to address to a number of Philadelphia city officials and copies of which were given to reporters of Philadelphia daily papers. The Phoenix Bridge Co., having been engaged to build a combined highway and trolley bridge of stated dimensions and under given specifications I have not felt at liberty to discuss these requirements either privately or publicly. After a careful examination of Mr. Roberts' letters I fail to find any scientific matter of public interest. The Pencoyd Bridge Co. may take great interest in having illustrated in your journal alongside of the Phoenix Bridge Co.'s plan their ideas of proper plan and length of spans, which might be adaptable to another location, but in the present case it is ruled out absolutely as unsuitable and not acceptable to the Park commissioners (see Russell Thayer's letter of invitation of May 31, 1895, above). The local conditions are such that the four-span crossing is necessary and was so fixed upon as long ago as 1894.

There are many specifications to choose from in undertaking to design a bridge, and their differences in some parisons, also used the limiting unit stresses, without bearing in mind that well known clause, which Mr. Theodore Cooper, from his wide experience has thought necessary to print on the outside cover of each copy of his specifications: "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

The Phoenix Bridge Co. try to interpret their own specifications on these lines and also any other specification which they are called upon to use from time to time. If Mr. Roberts had so desired he could have convinced himself by an examination of our detail stress sheet, giving sizes, etc., prepared several weeks before he saw fit to criticise the plan, that in no case have we used the limiting strains he finds, but have used our "common sense and professional intelligence" in designing and detailing the particular bridge under consideration, bearing in mind the duties it must perform. That we have not erred in our conclusions and judgment is borne out by the report just made to the sub-committee of Fairmount Park commissioners by their consulting engineer, Theodore Cooper, which you have reprinted.

Mr. Roberts' criticisms are answered in the following portion of Mr. Cooper's report:

> Capacity and Strength of the Structure.—This bridge has been proportioned for the following requirements: 1. The floor beams and stringers are to carry a loading of 100 lbs. per sq. ft. over all parts of the sidewalk and driveway or a 20-ton load on a wheel-base of 9 ft. on any part of the driveway; and for 1,000 lbs. per lin. ft. of the railroad tracks or an electric car weighing 25 tons loaded followed by another car weighing 20 tons loaded, on a total wheel-base of 78 ft.
>
> 2. The trusses are to carry the full area of the sidewalk and driveway over the whole span loaded with 80 lbs. per sq. ft., and 1,000 lbs. per lin. ft. over each railroad track.
>
> I consider the above requirements for the loading satisfactory and sufficient. In addition it is required that all parts of the structure shall be proportioned under these loadings so that the maximum strains shall not exceed those allowed by the Phoenix Bridge Co.'s specifications. As far as is shown on the general plans submitted, these allowed strains have not been exceeded. From the point of view of capacity and strength the proposed bridge can be considered a substantial structure.

Mr. Cooper's suggestions regarding number of spans, grade, pavement, cast curbs, gutters, hydrants, drainage, hand railing, auxiliary masonry piers, etc., are all matters in which the Phoenix Bridge Co. have no voice or interest, these points being determined by the committee of Fairmount Park or their representatives.

As I have intimated before, I find nothing to discuss in Mr. Roberts' letters that would be of great interest to your readers, and I can find no excuse or reason for their publication.

In June, 1895, we submitted tenders for the construction of the bridge in exact accordance with the letter and specifications received by Mr. Roberts (see copies above). In this competition with three other companies we were the lowest bidder and were so advised,

and Mr. Roberts' interest as a bidder ceased. About a year later we were asked to enter into a contract for the construction of the bridge, various modifications having been made in loading, width of sidewalk, width of trolley portion, total length of structure, wooden floor, etc. After considerable discussion we finally entered into an agreement to furnish the metal work in place. After we were well under way Mr. Roberts took up the matter as "a disinterested taxpayer of the city of Philadelphia," intimating that the loading was light, the Phoenix Bridge Co.'s specification not good practice, there should be only three spans, etc., etc.

In view of Mr. Cooper's report, his rights as a taxpayer do not appear to have been trampled upon to any serious extent.

I am able to say without qualification that the bridge as designed, in my judgment, will conform to best modern practice, and when completed will be one of the most substantial and ornamental highway bridges in the country. The photograph which I send you herewith shows the bridge as it will appear when completed. I shall be pleased to have an opportunity to make to the Engineering News, at a later date a full representation of the special features and details of this bridge, which I believe will be of general interest.

Respectfully yours,

John Sterling Deans,
Chief Engineer, Phoenix Bridge Co.

Phoenixville, Pa., Aug. 8, 1896.

TESTS OF NON-CONDUCTING COVERINGS FOR BOILERS AND STEAM PIPES.

The Boston Manufacturers' Mutual Fire Insurance Co. has issued a report by Prof. Chas. L. Norton, of the Massachusetts Institute of Technology, on the relative efficiency of different commercial coverings for steam pipes. His tests were made by a new method which consists in filling the pipe under trial with oil and heating the oil by a wire immersed in it which carries an electric current. The amount of heat radiated from the pipe is equal to the heat furnished by the current, which may be computed from the readings of a voltmeter and an ammeter. The accompanying tables give the results obtained:

Results of tests of Non-Conducting Steam-Pipe Coverings

Table I.—Test.—Temperature in the Pipe, 381.7° F., Corresponding to Steam of 200 lbs. Absolute Pressure; Temperatude of the Room, 72° F.

No.	Name.	Thickness, ins.	British thermal units per sq. ft. pipe per minute.	Ratio of heat loss to loss from bare pipe.	Weight, ounces per ft. of length.
1.	Nonpareil cork	0.90	3.04	0.254	21
2.	Magnesia	1.12	3.40	0.284	24
3.	Air cell No. 1	1.12	3.58	0.300	23
4.	Air cell No. 2	1.25	3.40	0.284	56
5.	Magnabestos	1.12	3.84	0.321	48
6.	Fire felt	1.00	3.99	0.333	46
7.	Calcite	1.25	5.02	0.423	29
8.	Bare pipe	....	11.96	1.000	..

Table II.—Temperature in the Pipe, 239.4°, Corresponding to Steam 10 lbs. above Atmospheric Pressure; Temperature of the Room, 72°.

No.	Name.	Thickness in ins.	British thermal units per sq.ft. pipe per min.	Ratio of heat loss to loss from bare pipe.
1.	Nonpareil cork	0.90	1.44	0.232
2.	Magnesia	1.12	1.59	0.262
4.	Air cell No. 2	1.25	1.58	0.261
5.	Magnabestos	1.12	2.32	0.383
6.	Fire felt	1.00	2.40	0.395
8.	Bare pipe	..	6.06	1.000

No. 1 was furnished by Stone & Duryee, Nos. 2 and 5 by Keasbey & Matthison, Nos. 3 and 4 by Asbestos Paper Co., No. 6 by H. W. Johns Co., and No. 7 by Philip Carey Co.

Full details of the method of conducting the tests are given in Prof. Norton's report. The results given above are averages obtained from 5 to 15 tests of each specimen, and the variations in individual tests were so small that the values of the ratios of efficiency can be depended on as correct within ½ %.

The circular contains also some important information concerning the liability of wooden laggings of cylinders and boxing of steam pipe to char and take fire. Wooden coverings of cylinders and steam pipes are apt to become completely converted into charcoal, and this may take fire immediately upon the entrance of air through the outer coving.

A caution is given concerning the use of mineral wool as a steam-pipe covering, as follows:

It serves only as a non-heat-conductor when in a very light and fluffy condition holding entrapped air. It is liable to be consolidaed by the vibration of the factory, leaving the upper part of pipes exposed, while the lower side is only guarded against radiation by this material becoming more and more solid and therefore less fit for its purpose. But this is not the worst. It is very dangerous stuff to handle. The fine needles getting under the nails will produce very injurious effects, and it is not safe to handle this material even in a laboratory without carefully protecting mouth and nose from the dust, which when breathed has produced hemorrhage. Much of this slag also contains sulphur or other elements which when wet or even dampened by escaping steam become very corrosive. Another type of a similar kind is known as Rock Wool. This appears to be made from glass and is therefore without corrosive effect, but is even more dangerous to handle than the mineral type. We therefore give this warning against the use of mineral and rock wool whenever offered to any of our members for covering pipes, and when used for any other purpose it should be handled with the greatest caution.

An addendum to the circular states that the caution regarding rock wool applies only to the use of the substance in its loose condition. A covering is made in which the material is so held in containing covers as to make it probably quite safe to handle and free from liability to injury by vibration.

Concerning asbestos and other materials used for coverings, the circular says:

Asbestos is one of the most valuable substances ever discovered for use in making pipe coverings and boiler laggings, but it is not because the asbestos itself is a non-conductor of heat; on the contrary, in a solid or compact condition, it is rather a quick conductor of heat, and must therefore be used merely as a bond for other substances or medium for holding entrapped air. Asbestos being an incombustible and fibrous substance may be and is used as a bond for holding magnesia, and other non-heat-conducting substances in position. It is also used in the manufacture of the Air Cell Covering for the purpose of holding a very large amount of entrapped air. In this way it serves a purpose for which it would be wholly unsuitable by itself, as it is liable to become more and more solid under vibration, even if first used in a porous or fluffy condition without combination with other substances.

The properties of magnesia in a loose condition holding entrapped air, the properties of what is known as fossil meal which is the diatomaceous earth, found under peat bogs, and the properties of cork in retarding the radiation of heat were well established by our previous investigation. The properties of air entrapped in a finely divided form, that is to say, entrapped in a material in which there can be little or no circulation of the air, have long been known. Hence success in making a pipe covering or boiler lagging has consisted in the combination of a bonding material of an incombustible kind, notably asbestos fiber, so as to hold the maximum amount of loose magnesia, loose fossil meal or entrapped air in the encasement which can be put on the outside of the pipe, and maintained without being impaired by vibration, or from other causes.

THE DETAILED COST OF 8-IN. PIPE SEWERS AT ITHACA, N. Y.

We have received from Mr. H. N. Ogden, Jun. Am. Soc. C. E., Chief Engineer of the Sewer Commission of Ithaca, N. Y., some figures relating to the detailed cost of 8-in. pipe sewers on 13 streets in that city, comprising a total length of 17,163 ft. The figures are given in the accompanying table and are supplemented by the following explanatory notes:

The column of cost of labor is based on observed number of laborers at the following assumed prices, which may vary a little from those actually paid: Foreman, $2; laborers, $1.35; masons, $3.50; tenders, $1.50; pipe layers, $1.50; teams, $3.50. Pipe, 12½ cts. per ft., with Ys 25 cts. each additional. Brick, $8. No amount for superintendence or profit is included. Teams were used for hauling pipe and cement from cars, and for cleaning up the streets. Amount not very regular, and probably partly inaccurate. The cost of manholes was made up sometimes by adding cost of brick and cement to labor, and sometimes by multiplying the depth by a determined amount per foot of depth. The manhole covers were bought separately, and are here estimated at 1½ cts. per lb. Cement was furnished by the city and delivered to contractor on the car. The cost to city was 95 cts. per bbl. The amount of cement used ranged from 120 to 243 ft. of laid pipe per bbl. Pipe was deep-socket pipe, and is estimated at 12½ cts. per ft. on cars here; all 8-in. The average cut given is found from the average of the different cuts for different distances along the trench, or is the true mean cut. Underdrains, where used, were furnished by the city; cost of labor only is included on Green St. Cost per foot per foot deep is found by dividing cost per foot by average cut. It eliminates the difference in the depth of trenches, and gives a fair comparison between the cost of pipe laying in the different streets, and between the different foremen. Cayuga St. only is paved (brick on 6 ins. of concrete) and the cost of repaving is not included. The other streets have a gravel surface. There were three gangs all and four gangs half of the month during which time the above work was done.

Detailed Cost of 8-in. Pipe Sewers in Sec. 7 of the Sewerage System of Ithaca, N. Y.

Street.	No. of day's work.	Cost of labor.	Cost of teams.	No. manholes.	Cost manholes.	Cost of manhole covers.	Cost of cement.	Cost of pipe.	Total cost.	Length laid, ft.	Cut, ft. Max.	Cut, ft. Min.	Cut, ft. Ave.	Cost per ft.	Cost per ft. per ft. deep.	Remarks.
Wheat	4	$126.50	$5.00	3	$29.00	$18.27	$13.56	$154.25	$346.08	1,134	6.7	4.9	5.3	$0.30	$0.056	Wet clay; water 3 ft. down, baled out; no pumping or sheeting.
Corn	5	200.70	7.00	5	53.00	30.45	24.18	196.50	511.83	1,504	7.2	5.8	5.8	.34	0.058	Wet clay; water 3 ft. down; no pumping; occasional bracing.
Washington	1½	49.50	2.00	1	8.00	6.09	4.34	51.25	121.18	398	6.4	3.5	4.9	.30	0.061	Wet clay; no pumping or sheeting.
Titus	4½	318.90	9.00	3	37.00	18.27	21.70	178.38	583.25	1,391	8.5	6.0	6.8	.42	0.062	Loam over wet clay; water 6 ft. down; no p'mp'g; occasional brac'g.
Plain	7	209.00	10.50	5	52.00	30.45	21.23	166.50	489.08	1,332	6.9	5.0	5.9	.37	0.063	Wet clay; water 5 ft. down; 1 diaphragm pump; occasional bracing.
Buffalo	4	108.25	6.00	3	35.00	18.27	14.41	78.63	260.56	597	8.1	5.4	6.7	.43	0.064	Clay and gravel; much water in places; pump; braced; some sheet'g.
Fayette	4	195.05	4.00	3	30.00	18.27	13.64	132.50	393.46	984	6.0	5.1	5.6	.40	0.071	Wet clay; water 4 ft. down; occasional bracing and pumping.
Centre	7	347.00	10.00	5	61.00	30.45	25.11	186.25	662.81	1,334	8.7	6.0	6.8	.50	0.073	Wet clay; water 3 ft. down; 1 diaphragm; occasional bracing.
Green	11	418.85	13.00	7	80.00	42.63	36.58	260.13	851.19	1,919	6.4	5.4	5.7	.45	0.078	Half gravel; remainder clay; half close sheeted; underdrain pumps.
Clinton	11	519.85	14.00	9	98.00	54.81	38.90	318.88	1,044.44	2,403	6.8	4.5	5.4	.43	0.081	Wet clay, 1 pump; occasional bracing; some gravel pockets.
Albany	9	319.50	7.00	4	50.00	24.36	21.54	187.38	609.78	1,431	6.6	4.2	5.0	.43	0.086	Gravel containing water at 5 ft.; half sheeted; pump.
Geneva	7	373.47	10.00	3	30.00	18.27	27.12	176.13	634.99	1,323	5.8	4.8	5.3	.48	0.091	Sheeting and pumping entire; water at 5 ft.
Cayuga	10	468.25	4.00	6	66.00	36.54	32.47	194.50	801.76	1,413	8.1	5.4	6.3	.56	0.090	Loose gravel; brick pavement half braced; half sheeted; no pump.

RULES FOR THE SANITARY PROTECTION of the water supplies of eight cities and nine villages have been established by the State Board of Health of New York in the past few years. The original authority for making such rules was given by Chap. 543 of the Laws of 1885, which required the approval of the County Judge of the county in which the waters are located. By Chap. 661 of the Laws of 1893, and amendments thereto, the rules established by the board take effect without the approval of local Judges. The cities for which rules have already been established are New York, Brooklyn, Rochester, Watertown, Syracuse, Elmira, Mount Vernon and Newburgh; the villages are Norwich, Cohleskill, Ilion, Fort Edward, Sing Sing, New Rochelle, Coxsackie and Skaneateles.

THE RELATIVE EFFICIENCY and cost of plumber's work has been investigated in detail by the London "Lancet" through a special commission appointed for that purpose. The commission gives three reasons for the large number of unsanitary houses: (1) The "prevailing indifference and consequent ignorance of all classes" regarding sanitary appliances; (2) bad work and cheap material as a result "of putting such work up to the distorted competition of all who may choose to tender for it;" (3) "the cost of rectifying sanitary work." After discussing these three reasons the report is chiefly taken up with a description of the plumbing in three imaginary buildings, with detailed estimates of the cost of making it good. Floor plans of the buildings are presented and many sketches of plumbing details showing how not to and how to do it. The report is published as a supplement to the "Lancet" for July 4, 1896.